SCIENCE.

FRIDAY, JULY 13, 1883.

THE GOVERNMENT AS A PUBLISHING HOUSE.

We have called attention to the report of Messrs. Ames, Spofford, and Baird upon the distribution of public documents, and noted the propriety of the recommendations made to the government by the committee. If these recommendations were to be carried out, something would be gained; but we have little faith that any real reform would be effected, for the evil lies deeper, and requires more radical treatment.

Ever since the government went definitely into the printing business in 1861, the evil has been growing, until now there is waste, confusion, and public mischief. It is no more essential to government to carry on the large printing business which it conducts than it is for it to manufacture paper. Let us make a distinction. There is a necessity, in the ordinary administration of Congress and the executive department, for a large printing-office in the immediate vicinity; and we are quite ready to grant, as immaterial to our argument, that it is better to have such an establishment, with its manager as a civil officer of the United States, immediately under the control of Congress. There is a vast deal of printing required in the exigencies of the daily business of government, and there is reason for this being done by persons hired directly for the purpose.

There the necessity stops, but the business of the printing-office does not. Costly scientific reports are manufactured year after year, and then published; that is, given away recklessly and with little discrimination. The report of scientific experts, to which we have referred, points out the desirability of a single agency for distribution, which should act upon some systematic plan. We do not object to a policy by which government shall put before the public the results of the surveys and experiments which it is carrying on; but we contend, that, in doing this, it should employ economic agencies already existing, which are far more efficient than any immediate governmental agency can be.

Government should contract with publishers to print and publish its scientific reports. The plan is perfectly feasible. Every copy which the government might wish to give away to public libraries could be bought of the publisher at a cost fifty per cent less, we venture to say, than government now pays for the same work. It would be the publisher's business to make the work known everywhere; and such a work would be far more read than it now is, for it would be made as other books are, and brought before the people intelligently. By such a policy no scientific organization or student of science now in communication with the distributing-office would suffer loss, while a great many people who are accustomed to get their books from booksellers would come into possession, in the most natural way, of this important body of literature.

The effect of such a system would be to contract the business of the government printing-office, and that is an end devoutly to be wished for by every honest citizen who sees the necessity of checking corruption by limiting the opportunities for corruption. The fewer salaried offices this government has, the less chance there is for an abuse of the civil service; and science will gain nothing by asking favors of the machine. There is an excellent opportunity here for the educated classes to enter a protest, and to encourage a reform in administration. We have been demanding that the administration should be conducted on business principles; and the present system by which government prints and publishes books is un-businesslike, extravagant, and in peril of being scandalous.

THE NATIONAL RAILWAY EXPOSITION.[1] — II.

THE numerous accidents that have occurred owing to the signals showing 'clear' when the switches were set for a side-track led to the invention of 'interlocking,' which is now used extensively in England, and is being introduced into this country. The term 'interlocking' applies to a system where the switches and signals can be so worked by levers concentrated at one point, that no safety-signal can be given for any track until the switches are properly set for the safe passage of the train; and, when the signal is set to safety, none of the switches can be moved until the signal is again made to indicate danger. The advantages of this system are, that one man can operate a large number of switches and signals, and the interlocking apparatus acts as a check upon him, and renders it impossible for him to commit a mistake and move a wrong lever; and the mechanism is so arranged that a certain definite routine must be gone through in making a safe course for a train. The signals standing at their normal position of 'danger,' the switches are first moved, then they are locked firmly in position: then only can the danger-signal be changed to safety for the passage of the train when all possible conflicting signals or switches are locked, so that they cannot be operated. When a certain track has been prepared for the safe passage of a train, the necessary alteration of switches and signals is begun at the point farthest from the train, and ended at the signal nearest to it, this signal being locked to indicate danger until the track is ready for the train; and the setting of this signal to safety shall lock to danger all conflicting signals not already locked.

The amount of safety secured by the adoption of interlocking apparatus is thus laid down by an English author: "If a man were to go blindfold into a signal-box with an interlocking apparatus, he might, as far as accordance between points and signals is concerned, be allowed with safety to pull over any lever at random. He might doubtless delay the traffic, because he would not know which signal to lower for a particular train; but he could not lower such a signal, nor produce such a combination of position of points (switches) and signals, as would, if the signals were obeyed, produce a collision."

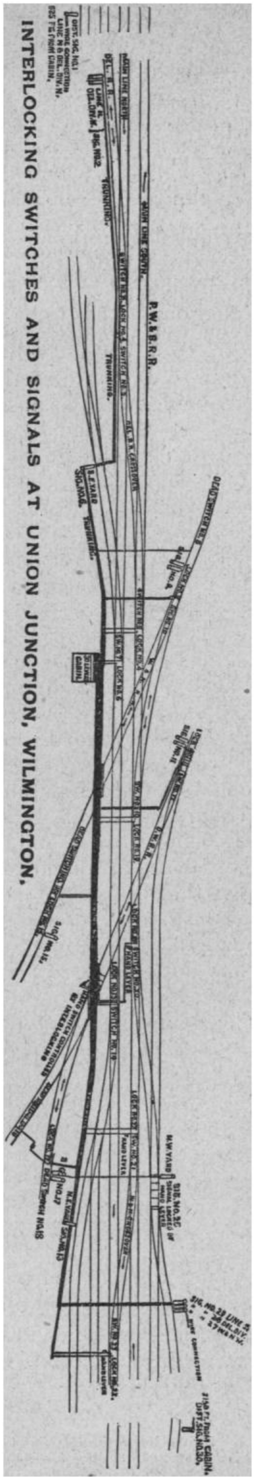
Interlocking has been very generally adopted in England, but hitherto little attention has been paid to the subject in this country; though in some crowded depots, such as Lowell, Wilmington (Del.), and Boston (Boston and Albany railroad), it has recently been introduced with great success.

The two principal exhibits of interlocking and signalling apparatus at the Chicago exposition are those of the Pennsylvania steel company and the Union switch and signal company; Mr. George Westinghouse, so well known as the inventor of the break bearing his name, being the president of the latter company. The Union switch and signal company exhibits several distinct methods of working switches and signals controlled by interlocking apparatus. First, the Saxby and Farmer method, which is very generally used in England, and in some station-yards on the continent; Brussels, for example. In this the whole work of moving the signals and switches is effected by the manual power of the signalman. But as this involves considerable physical exertion in places where the levers are numerous, and some of the signals are a considerable distance away, Mr. Westinghouse has introduced a system whereby the signalman only moves valves admitting either compressed air, or a mixture of water and wood, or methylated spirits of wine, to cylinders, the pistons of which perform the actual hard work of shifting the switches and signals. The Pennsylvania steel company shows an American invention, which proceeds on similar lines to the Saxby and Farmer apparatus, attaining, however, the same end by the use of fewer levers. As, therefore, these two systems are very similar, except as regards mechanical details, into which we need not enter here, the following description of the general methods and purposes of interlocking mechanism will apply to both exhibits. The whole question is novel on this side of the water, and will well repay a careful study by all those who are interested in the progress of railroads.

One of the points that has been equipped with interlocking apparatus by the Pennsylvania steel company is shown in the accompanying plan of tracks at the Union Junction of the Philadelphia, Wilmington, and Baltimore railroad, at Wilmington, Del. This junction is one mile west of the passenger-station, at the crossing (at grade) of the Wilmington and northern railroad and of the Delaware western railroad, where the Delaware railroad branches from the main line of the Philadelphia, Wilmington, and Baltimore railroad. Through trains pass this junction at lightning express speed. The main line is protected from crossing roads by dead

[1] Continued from No. 22.

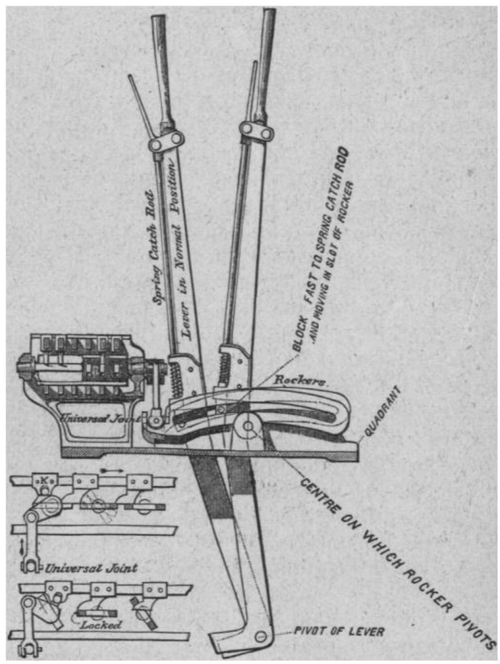
switches on the crossing roads, so that crossing trains running against signals will be turned into a side-track, and cannot, therefore, cross or foul the main line. There are, in all, fifteen switches handled and controlled, and three other switches not handled (owing to the infrequent use, or being required only for hand-drilling), which are also perfectly controlled. Twelve facing point locks and seventeen signals are employed, some of them 2,150 feet from the signal-tower. To operate the above, twenty-eight interlocking levers are used, with two spare levers in the frame for future improvements. At this writing, the apparatus at Union Junction has been in use over one year with perfect success, and it will probably repay any railroad manager to visit it, and study its workings.



INTERLOCKING SWITCHES AND SIGNALS AT UNION JUNCTION, WILMINGTON.

In arranging a yard on the interlocking system, it is important to concentrate the switches so that they can be worked by one man from one machine, where as many as fifty levers operating switches and signals can be conveniently arranged. Provided that the yard is well laid out, it is possible not only to gain greater safety and security in switching and drilling, but a saving in time and labor is effected, as one man who is always on the same spot can perform the work of several men scattered about a yard, and having continually to move from one spot to another. The levers should be placed in a house constructed so as to shelter the signalman from the weather, and enable him to have a good view of the whole yard; and the latter object is generally best attained by placing him at some distance above the ground-level, so that his view is not obstructed by passing engines and cars.

The levers, which resemble the reverse lever of a locomotive, are mounted close together in a line, and a name or number plate on each lever shows its use and purpose; and,



to further distinguish the levers, all those operating switches may be painted one color, locking levers another color, and so on. Each hand-lever carries a spring-catch, which secures the lever at either end of the stroke; and the detent, forced down by the spring, and pulled up by the action of the signalman's hand in grasping the handle-end of the lever and its catch, instead of engaging in a notched rack, as on a locomotive, slides in a curved slot in a pivoted bar. This bar, or 'rocker,' is therefore moved about its pivot by the very action of the signalman grasping the lever. Interlocking virtually consists of mechanism attached to this pivoted bar, which renders it immovable under certain circumstances. These controlling circumstances are the posi-

tions of certain of the other levers in the frame. To exemplify this, we will take three levers, A, B, and C. If A and B be in such position that a signal given by the movement of lever C will be dangerous or misleading to a train, the pivoted bar connected to lever C is locked, and cannot be moved by any exertion of strength on the part of the signalman; and therefore he cannot even begin to move lever C, and the possibility of giving a wrong signal is put beyond doubt. Similarly, nothing is effected unless the lever completes its stroke. The pivoted bar or 'rocker,' through which the whole work of interlocking is done, moves only at the extreme ends of the stroke of the levers, and then is only moved by the rising or falling of the spring detent. This invention, simple as it seems, is the result of many years' experience, accidents having often occurred through a lazy signalman pulling his lever through part only of the stroke, and thus only partially effecting the locking. This is now impossible; and the *intention* of a switchman to move a lever, expressed by his grasping the lever and so moving the spring-catch, independently of his putting the intention into force, actuates all the necessary locking.

The details of locking-apparatus are somewhat complicated, but the principle is simple. Certain bars carrying lugs or projections are made to slide or move by the movements of the rockers. Certain other bars, which are also moved by the action of one or more rockers, are slotted or pierced with holes, so that, in certain positions, the lugs in the first set of bars can enter the holes in the second set of bars, and, in other positions, the lugs strike against the bars, and cannot be moved. It is, of course, obvious that the arrangement is such as to prevent unsafe or contradictory signals being given, and permit only of safe or harmonious signals; and, by a careful arrangement of the locking-apparatus, it is sometimes possible to make a few movements effect important changes of the switches and signals with a minimum of levers and complication.

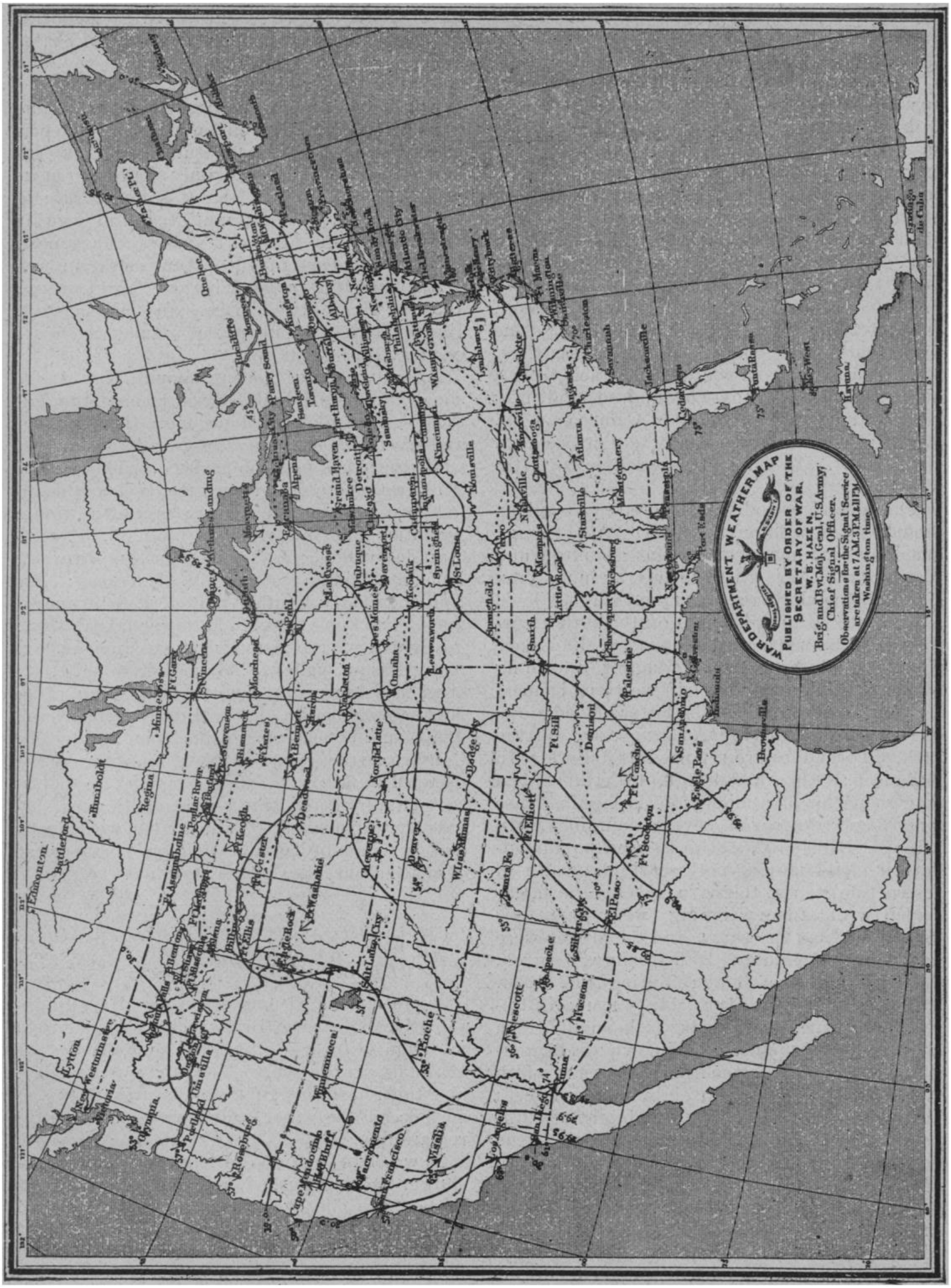
It is obvious, that, when switches are worked from a distance, there is a chance of the switch being incompletely closed, owing either to dirt, or a stone, or ice, choking the switch itself, or the switch-rods working it. There is also a danger that the switch-rod might break or become disconnected, and that, though the signalman moved all his levers, and all the locking and unlocking was properly performed in his cabin, yet the switch itself might remain unshifted, or be left half open. To obviate this, the facing point lock was invented. This is a bolt which can only be shot into a crossbar connecting the two rails of the switch when the switch is either properly closed, or wide open. A failure of the switch connections, or an obstruction in the switch, will render it impossible for the bolt to enter the opening to lock the switch; and, as the signalman's lever actuating this lock interlocks with the signal levers, no train can be signalled to approach until the switch is either closed, or wide open, as the case may be, and firmly locked in its proper position. But another danger has to be guarded against: signalmen, to save time, will generally throw a signal again to danger directly the engine of an approaching train has passed; his other levers are then set free, and he can unlock his switch, and actually change the switch, before the whole train has passed, thus probably throwing the rear vehicles off the track, and causing a serious accident. To guard against this, a locking or detector bar is used, which lies near the rail, but clear of a wheel, when the switch is either shut or full open; but directly the switch is moved from either of these positions, the bar moves close to the tread of the rail, and takes such a position that it must come in contact with any wheel approaching the switch. As the bar is made longer than the distance between any two trucks, it follows, that, as long as a train is passing over the switch, one or more wheels of the train must prevent this bar being moved, and, as the switch-lock and the bar are arranged to move together, it follows that the switch cannot be unlocked until the last truck of the last car of a train has passed. The Union switch and signal company adheres to Saxby and Farmer's arrangement of this bar where it moves vertically. The Pennsylvania steel company shifts it laterally. The latter movement is more easily performed, and the bar can serve as a guard-rail; but its movement seems somewhat liable to be impeded by snow falling between the rail and bar.

(*To be continued.*)

THE WEATHER IN MAY, 1883.

THERE have been two periods of very severe storms, and at many places of tornadoes. The first of these accompanied a 'low,' first noted in Colorado[1] on the 13th. This moved with considerable energy over Colorado and Nebraska. On the 14th, increasing in energy,

[1] It has been found necessary, owing to the smallness of the appropriation, to give up all telegraphing reports west of the Rocky Mountains: hence the charts are made up only to the east.



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, MAY, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF CHIEF SIGNAL-OFFICER.

it advanced into Ohio. At the morning observation of this date, pressures .5 to .6 inch below the mean were noted in Iowa.

Reports of hail on the 13th, 14th, and 15th, sometimes of astonishing size, have been sent from thirty-six stations, mostly in Iowa, Kansas, Missouri, Indiana, and Illinois. The following is a brief summary of tornado reports. Indiana: Amity, 14th, 7.30 P.M.; Waterloo, night of 14th, only three houses left standing; Muncie, night of 14th; Indianapolis, 14th, 6 P.M. In Kansas: Troy, 13th, 5 P.M.; Muncie, 13th, 4.30 P.M., most violent storm ever known in the county. In Michigan: White Pigeon, 14th, 4 P.M.; Sturgis, 14th, 3.30 P.M., came from south-east. In Missouri: Kansas City, 13th, 4.30 P.M., from south-west, track from a hundred and fifty to two hundred and fifty yards wide, damage $300,000; Cameron, 13th, 5 P.M.; Macon, 13th, 8 P.M.; Pattonsburg, 13th, 5 P.M. In Ohio: Frederickstown, 14th, afternoon.

The second period was ushered in by a deep 'low' in Colorado on the 17th. At 11 P.M., Washington time, pressures at Yankton and North Platte were 29.16 inches, or more than .7 inch below the mean. On the 18th the 'low' moved into Minnesota, and on the 20th a portion of it moved east into the St. Lawrence valley; while its influence was felt in forming a second subsidiary 'low' in western Tennessee on the same date. The latter moved slowly, and passed off the Atlantic coast on the 24th. Tornadoes are reported as follows. In Arkansas: Eureka Springs, 18th; it cut a path a quarter of a mile wide through a dense forest, and destroyed several buildings. In Illinois: Hillsboro', 18th, 10 P.M., a funnel-shaped cloud moving north-east, the width of destruction, ten to thirty rods; Grafton, a car loaded with stone weighing twenty-one tons was lifted from the track, and the stones were scattered; Chemung, 18th, before 6 P.M.; Chicago, night of 18th; Springfield, 18th, 7.10 P.M.; Pesotum, 18th, 11.30 P.M.; Littleberry was nearly destroyed; Jacksonville, 18th evening, severest storm ever known; Edwardsville, 18th evening, came from south-east, width of track six hundred to eight hundred feet; Tallula, 18th, 9 P.M. Up to midnight of 19th, the number of deaths in Illinois caused by the tornadoes of this date was sixty-three. In Missouri: Moody, 18th, 19th, every house blown down; Berger, 18th, 7 P.M., six houses and one mill destroyed; Oronogo, 18th, 7.40 P.M., six persons killed, $75,000 damage. New York: 21st, one of the severest storms that ever visited Long Island. In Tennessee: Chattanooga, 20th, 4 P.M. In Wisconsin: Janesville, 18th evening; Racine, 18th, 7 P.M., twenty-five people killed, damage $60,000, track five hundred yards wide.

The chart of monthly isobars, isotherms, and wind-directions is given on p. 35. The permanent summer low-pressure area has enlarged a little, and moved only slightly from its position last month. Mean pressures are in general below the normal, except in Florida and the upper Missouri valley. The mean temperature east of the 100th meridian was 3.1° below the mean; highest temperature, 109° at Eagle Pass, Tex., and Yuma, Cal. Illinois and Missouri report damaging frosts on the 22d.

A comparison of floating ice with May, 1882, shows the eastern limit 3° west of last May, but the southern limit is the same. The number and size of icebergs are much less than last year, while there has been no field-ice. The Gulf of St. Lawrence, blocked last year, is clear this.

There were deficiencies in rainfall: Middle Atlantic, .58 inch; West Gulf, 1.50; Rio Grande valley, 2.93; extreme north-west, 1.65; and middle plateau, .69. Excesses: New England, 1.41; South Atlantic, 2.91; Tennessee, .54; Ohio valley, .77; lower lakes, 3.02; upper lakes, .85; upper Mississippi valley, .68; Missouri valley, 3.03; middle slope, 1.09; southern slope, 1.91; northern plateau, .99; North Pacific coast, .86; Middle Pacific coast, 2.33; and Southern Pacific coast, .80. In California the rain has been four times the usual May fall.

A hundred and thirty-nine cautionary signals were displayed, of which 84% were justified by winds of 25 miles or more per hour, at or within 100 miles of the station.

SYMMETRICAL LINEAR FIGURES PRODUCED BY REFLECTION ALONG A RIVER-BANK.

In July, 1882, I noticed on the Magaguidavic River, in New Brunswick, some figures, apparently formed through combination of actual fissures in the rocks at the water's edge, and the reflections of these fissures from the surface of the water, which were not a little remarkable.

It was late in the afternoon. One thunder-shower had just ceased, and another was about to begin. The sky was somewhat overcast, and the water more or less shaded by the forest which covers most of the adjacent land. The banks of the river are bold, the shore being lined in many places with steep rocks having abrupt

faces. Thanks to the lifting of the salt or brackish water by the tides, the boughs of the trees which overhang the river are trimmed off sharply and squarely, as if by shears, at a plane which marks the limit reached by the water of the highest tides. By the same means, the rocks on the strand are kept clear of vegetation; so that there is ordinarily a well-defined wall of bare rock between the water and the trees, even when the tide is high, and the river not far from being full. At the time I am speaking of, there was no wind: the surface of the water was absolutely glassy, and a superb reflection of the foliage of the forest was to be seen in the mirror which the river made. I had just remarked to a chance companion on our little steamboat how difficult it was to distinguish between the water and the land, so completely were the real rocks and trees blended with their reflections, when my attention was attracted by a rock, apparently at the water's edge, which was covered with symmetrical lines and figures. I called out to a friend, who was standing at some distance from me on the deck of the boat, to 'look at the pictured rock,' and, on turning from him to again look at the shore, I perceived that it was not one rock alone that bore figures: there was a long, broad ribbon or dado of similar picturing at the edge of the water, running along the shore between the real trees and the picture produced by the reflection of the trees in the water. I am fortunate in being able to say that my friend saw the picturing on the rock to which his attention was thus hastily directed, for the fact enables me to dismiss the notion that the figures might possibly have been 'subjective' to myself. I had, however, hardly time enough to get a fair view of the picture before a new shower of rain ruffled the water, hid the shore, and drove us under cover.

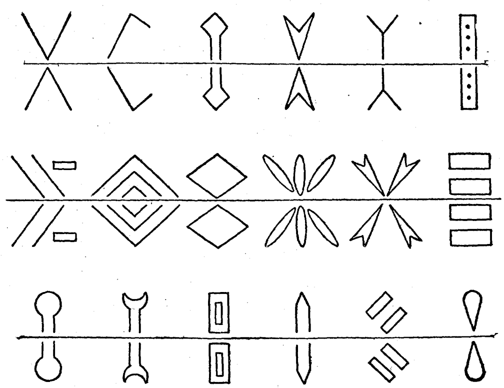
Beside herring-bone patterns, there were symmetrical lines, bars, and flutings of various lengths, together with figures suggesting short maces, staves, or even spears and arrows, as well as others in the semblance of hieroglyphics. Indeed, the whole effect was very Egyptian-like; while many of the lines recalled those so commonly used of late years for ornamenting furniture, — such lines as are, I believe, technically called 'reeding.'

On thinking the matter over, I was at first inclined to believe that I must have been looking into a great natural kaleidoscope; but, on further consideration and observation, it seems plain that simple reflection — that is to say, duplication by the water-mirror of lines, cracks, dents, or scars upon the rocks — might account for most, if not for all, the appearances I witnessed. I regret that the attitude of mere wonder and admiration into which my mind was thrown should have hindered me for the moment from making a proper critical examination of the figures; but I have been impressed by the conceptions that similar appearances cannot possibly be infrequent when the water of the river is still, and that some of the first rudiments of primitive art did probably originate in efforts made to copy such natural lineations as these.

There is, I believe, an old, perhaps it is an endless, dispute as to whether, in the history of human art, such kinds of ornamentation as herring-bone figures, reeding, and fluting have ever been derived from a direct imitation of natural objects, or whether they have not always arisen from mental conceptions. It has seemed to me that the observation here recorded should bear with considerable force in favor of the view of those students who refer the beginnings of all things to facts of actual observation and experience.

I am well aware that the atmospheric conditions were of somewhat exceptional character at the moment when I saw the picturing; but it is evident that rock-fissures, properly placed as regards a body of still water, will naturally be duplicated by reflection therefrom. There is every reason to suppose that figures analogous to those I witnessed may often be seen where rocks and water meet, and it is hard to believe that they have not been seen frequently by persons favorably situated. There is consequently no improbability in the idea that some of the primitive designs of savage nations may have been copied from them. Different effects would, of course, be produced in different localities, according to the quality and mode of stratification of the rocks, and to the nature of the jointings, seams, and scars which the rocks bear; and it is not unlikely that the rocks on the Magaguidavic River may be peculiarly well fitted for exhibiting these pictorial effects. But the capital fact of duplication by reflection must be common to all localities; and there are probably many places where ornamental figures would be produced by mere force of repetition even of very simple forms; that is to say, by the formation, at one and the same time, of a series of figures comprising many individual reflections, each one of which was similar to all the rest. A general idea of some kinds of forms that may possibly be seen where cracks in rocks are reflected from a body of calm water may be got by drawing figures like those of the diagram which I have selected

from a hundred or more that occurred to me. No effort has been made in the diagram to copy the actual appearances seen on the river-bank.



An essentially different style of representation would be needed in order to convey a just conception of the effect of the scene I witnessed. With the exception of the herring-bone figure, I cannot profess that either of the figures of the diagram is like any of those I saw in New Brunswick. It is to be remembered, however, that, whatever the forms may be that are produced by reflection from one particular bank of rock, the same kinds of forms will usually and probably be repeated again and again with the result that a pattern or 'design' will be produced.

I consider myself so little qualified to look up a matter wholly foreign to my usual studies, that I have made no effort to search for records of observations similar to the one here described, though I am strongly inclined to believe that such records must exist. I would say merely, that on again steaming up the Magaguidavic River at a time when a breeze was stirring, and the surface of the water was ruffled, I saw none of the picturing excepting in one quiet nook or cove, where a series of really superb herring-bone figures was produced by reflection from the surface of the calm water of the lines of stratification between the beds of rock, which were here tilted at a considerable angle. Although during this second visit I saw none of the 'reeding,' or of the other kinds of symmetrical figures which had so much impressed me before, the multiplicity of the herring-bones, i.e., the continued repetition of this figure, was specially noteworthy. A peculiar kind of beauty or sense of satisfaction to the eye was thus obtained, which a single figure would clearly not have been competent to give. It is reasonable to suppose, that wherever complete herring-bone figures are formed, as here, by reflection of those lines between the layers of rock which are continuous, and, so to say, perfect, a variety of related or derived figures will be produced by the reflection of lines which are not continuous; that is to say, the reflections from lines that are imperfect in any way, or broken into various lengths, would give rise to hieroglyphic characters in considerable variety, though they might all belong to one common group or kind.

At the time of my second visit to the river, I could see no reason to doubt that the figures might be seen almost any day when the time of high tide, and consequently of a full river, happened to be coincident with the calm moments so common in summer at the hours not far from sunrise and sunset.

As bearing on the question of human imitation, it is of interest to note, that while herring-bone patterns would naturally be produced wherever the lines of stratification of tilted layers of rock are reflected from calm water, i.e., in numberless localities, it is precisely these figures which have been most frequently delineated by savages upon pottery and other implements as one of their earliest artistic efforts.

Excepting the two instances here recorded, I have never noticed any such figures in the course of my own travels, nor have I heard of their being seen by others. I am assured, moreover, by several of the most competent and experienced observers of my acquaintance, that they have never witnessed any thing similar. I expect, however, for my own part, to see such figures from this time forth, when opportunity offers, and I trust that many other persons will do so. It is to be hoped, withal, that some of the more noteworthy effects of this sort may be accurately depicted.

F. H. Storer.

THE AMERICAN SWAMP CYPRESS.

The following observations on the bald or swamp cypress of the southern states are condensed from the forthcoming second volume of the memoirs of the Kentucky geological survey. They embody the results of certain inquiries which show that this peculiar tree deserves more study than has been given to it by our botanists.

The Taxodium distichum is, as is well known, a common tree in the swamps of the southern states, extending from New Jersey to Texas, and northwardly in the Mississippi valley, to the lowlands of southern Illinois. It has several titles to distinction: it is not

only in all its proportions the noblest of all our coniferous trees east of the Rocky Mountains, vying in girth and height with the yellow poplar (the Liriodendron tulipifera of the botanists), but it is by far the most stately all the of trees belonging on the eastern face of the continent. Moreover, it has certain habits which are altogether peculiar to its species, and which constitute it a very exceptional member of the Coniferae.

When this tree grows on the dry ground, or on a surface where the water does not stand during the summer half of the year, it differs in no important feature from its kindred species; but, when it grows in swamps which are flooded during the spring or summer months, the roots form excrescences, which rise so that their crests overtop the level of the water during these seasons. These excrescences are of varying height, their projection above the level of the roots depending on the depth of the swamp-waters during those seasons of growth. These conditions may be satisfied by projections, or 'knees' as they are called, that rise only a few inches above the root, or they may rise to the height of five or six feet above the soil. These knees are sub-cylindrical in form; near the base they are elongated in the direction in which the root extends; above, they give a nearly circular section; at the top they are crowned by a cabbage-shaped expansion of bark of irregular shape, rough and warty without, often hollow within. They are often as much as eighteen inches in diameter. They are so commonly hollow, and of such size, that they are sometimes used by the natives for beehives or for well-buckets, for either of which uses they are tolerably well adapted. A tree of large size, say six feet in diameter, will often have as many as thirty or forty of these knees projecting above the swamp-water which surrounds its base.

Looking closely at these knees, we observe, that, unless they are evidently decayed, they generally have a very porous, spongy bark over the surface of their crests; and the bark on this summit, peeling off from time to time, often exposes a singularly spongy surface, such as we find in the inner bark of the pine-tree when the coarse outer bark is peeled away.

There have been many conjectures as to the function of these knees. It has been supposed that they were in the nature of suckers or branches from the roots, which gave rise to new trees; but, after examining thousands of these knees, I am convinced that they never have this nature. In no case have I seen or heard of any buds appearing on them. The only clew to their function I have obtained in the following way: whenever it happens that the knees become entirely submerged during the growing season, the trees to which they belong inevitably die. Very extensive proof of this point was given by the general submergence of extensive districts during the earthquakes of 1811–13, in the region near the Mississippi, where the cypress-trees over a region several hundred miles in area were killed by a subsidence that brought the water a foot or two below the crests of the knees. In Reel-Foot Lake, in Kentucky and Tennessee, thousands of these long ordinary cypress-boles still stand in the shallow waters, though it is now seventy years since they were killed by the slight submergence of their knees.

The same thing can be seen on a smaller scale in several mill-ponds in western Kentucky, where the change in level of the swamp-water has brought these excrescences below the surface of the water. These facts — viz., the absence of the knees when the tree grows on high land, and the death of the tree when the knees are permanently submerged — lead me to the opinion that the use of these excrescences is to bring the sap while in the roots in contact with the air. That they have this function is made more probable by the fact that their heads, i.e., the parts which always project above the water during the growing season, remain very vascular, and, by a process of desquamation, secure the exposure of the inner bark to the air.

It is evident that this tree affords us a very interesting instance of a specialized structure, that only develops when the plant occupies a certain position. We often find this tree artificially transplanted to the gardens of the western country. It then shows no distinct tendency to form knees, though the surface of the roots show a few short spurs not over an inch or so high.

It is a well-known fact that the genus Taxodium dates back into the early tertiaries. I am not aware, however, that fossil knees have ever been found. We have only to examine the borders of the swamps to see that it cannot, on the uplands, maintain a battle with the contending broad-leaved trees, though in any artificial open place it will grow with singular luxuriance.

It seems to me likely that we have here a very interesting case of a species owing its survival to a peculiar habit of growth. There can hardly be a doubt that the kindred of this Taxodium held an important place on the continent before the development of the broad-

leaved trees. It seems not unlikely that it was crowded out on the higher ground, and forced to limit itself to this station which the swamps afford. In these permanent though shallow waters it clearly has an advantage over the broad-leaved forms of trees.

I am not aware that any structures resembling these knees are found among other plants. If it be the fact that they are peculiar to the Taxodium distichum, we have in this species a very remarkable case of a peculiar organ developed for a special purpose.

There is another interesting problem concerning this species. The seeds *seem* to germinate beneath the water. I have seen many young trees growing in what must be permanent swamp, where the soil was buried to the depth of a foot or more. I have long desired to try some experiments on this point, but have not been able to do so. I hope that some observer will undertake the inquiry.

This tree is certain to have a great economic value. Its great size, its favorable position in relation to our great water-courses, its very rapid growth and excellent timber qualities, are all calculated to commend it for use as a constructive wood. There are many million acres of land in the southern states where it could be cultivated to advantage. If kept from competition with the deciduous trees, it will do as well on any moist lowlands as in the actual swamps. Its growth is more rapid than that of any other of our timber-trees; the wood is said to be much stronger than that of any pine; it endures well in the open air without paint, as is shown by the fact that the trunks of trees killed in 1811 still stand undecayed in the swamps near the Mississippi River.

N. S. SHALER.

RECENT BABYLONIAN RESEARCH.

IN the Proceedings of the Society of biblical archeology for November, 1882, Mr. T. G. Pinches, the Assyrian scholar of the British museum, reports a discovery of more than ordinary interest. This is an historical notice on an inscribed cylinder, coming from the ancient city of Sippar, and belonging to Nabonidus, the last of the native Babylonian kings. The cylinder was written before Cyrus had captured Babylon, but after his conquest of the Medes. The inscription of Nabonidus, after the usual introductory formulas, relates the reconstruction of several famous temples. The first of these, the temple of the Moon-god at Haran, had been destroyed by the Medes. Being instructed by the gods Marduk and Sin to rebuild it, Nabonidus recalls for this purpose his armies from Gaza, on the borders of Egypt. He informs us that the temple had once before been restored by the Assyrian king Assurbanipal (Sardanapalus), and that he found, while engaged in the work, the inscribed cylinders of Assurbanipal and of Shalmaneser II.

The great historic event referred to in this part of the inscription is the fall of the Median empire before Cyrus the Great. When commanded to restore the temple by the god Marduk, Nabonidus replies that the Medes have destroyed it, and receives from Marduk the promise that they in their turn shall also be destroyed. Nabonidus then relates: "At the beginning of the third year, they (the gods) caused them (literally 'him,' the Median nation) to go out to war; and Cyrus, king of the land Anzan, their (lit. 'his,' i.e., the Median nation's) young servant, overthrew with his small army the Median hosts, captured Astyages, king of the Medes, and carried him bound to his own (Cyrus's) land."

The undoubted value of this passage for the solution of the riddle left us by the conflicting testimony of the Greek writers, as to the relations of Cyrus and the Persians to Astyages and the Medes, is in part impaired by the ambiguous use of the pronouns. It is partly owing to this ambiguity that the translation just given differs from that of Mr. Pinches, who renders: "In the third year, he [the god Marduk] caused Cyrus, king of Anzan, his young servant, to go with his little army; he overthrew the wide-spreading Ṣabmanda [Medes], he captured Ištumegu (Astyages), king of Ṣabmanda, and took his treasures to his (own) land." It is difficult to say whether the words 'his servant' mean servant of Marduk, as Mr. Pinches supposes, or servant (= tributary) of the Median people; but the latter seems, for certain grammatical reasons, more probable. It is also improbable that Nabonidus, a special votary of Marduk, should speak of Cyrus, a foreigner, as a servant of the same deity, although we know that later, perhaps for state reasons, Cyrus was friendly to the worship of Marduk (V. Rawl. 35). It is more probable, that, when Nabonidus mentions Cyrus as 'his small servant,' he means to say that Cyrus was a vassal prince to the Medes. The translation 'him bound' (*kamûtsu*, lit. 'his bondage'), instead of 'his treasures,' is well established (I. Rawl. 13, 24 ff.), and adds not a little to the interest of the passage.

In the cuneiform annals of Cyrus, written after he had captured Babylon, we have this monarch's brief account of the war with Media (*Trans. soc. bibl. arch.*, vii. 155 f.). After a renewed careful collation of this important passage, Mr. Pinches has published the original a second time (*Proc. soc. bibl. arch.*, Nov., 1882). It is unfortunate that the ends of the lines are lost by mutilation of the clay tablet containing the inscription. Following is a translation of this passage: "[Astyages relied upon his troops] and marched against Cyrus, king of Anšan to [capture him?] . . . The troops of Astyages revolted against him, made him prisoner [and delivered him] to Cyrus . . . Cyrus (marched) to Ecbatana, the royal city. [He captured] the silver, gold, treasures (?), (and) possessions (?), which Ecbatana had gotten by plunder and he carried to Anšan the treasures

and possessions which [he took?]." This version differs slightly from the one offered by Mr. Pinches, but not as to the revolt of the troops of Astyages, his delivery to Cyrus, and the capture of Ecbatana.

The accounts of Nabonidus and of Cyrus vary somewhat. The language of the former implies a battle in which Cyrus defeated the Medes and captured Astyages, but does not mention a revolt, nor the capture of Ecbatana, the Median capital. The account by Cyrus, being the state annals, is likely to be the more exact, and enters more into detail than that of Nabonidus; but the two are not at all contradictory. All that Nabonidus wished to record was the overthrow of the Median power and the capture of their king, and it was unimportant whether this took place in battle or by mutiny. It may be that he did not know the details of the war, or it is possible that one division of the Median army gave battle, while another mutinied and delivered Astyages to Cyrus. There is an apparent difference in the two accounts as to the date of the capture of Astyages. According to the Cyrus text, this event took place in the sixth year of Nabonidus, while Nabonidus says that it occurred in the 'third year.' It is, however, not clear from what point Nabonidus reckons, — perhaps from the date of his dream.

There is nothing in either of these accounts to show whether Cyrus was in any way connected by birth with Astyages. As to the relation of the countries of Media and Persia at this time, it is clear, from the language of Nabonidus, that Persia was a very small power; and if the word 'his servant' (*aradsu*), as applied to Cyrus, means the servant of the Medes, the conclusion would be that Cyrus was a tributary king to the Median power. This agrees with the statement of Herodotus (i. 107), that Cambyses, the father of Cyrus, was considered by Astyages as of respectable family, but inferior to an ordinary Mede. Nicolaus of Damascus also makes Persia subject to Media (Müller, *Frag. hist. Gr.*, iii. 399, Fr. 66).

It is certain that the mystery surrounding the relations of the Median and Persian courts and people can never be cleared up with the aids hitherto possessed. Nothing but the contemporaneous literature of these peoples themselves, and of neighboring peoples, can ever solve the problem. In another inscription Cyrus calls himself the king of Babylon, son of Cambyses king of Anšan, grandson of Cyrus king of Anšan, descendant of Šišpiš king of Anšan, royal offspring (V. Rawl. 35). This language is, however, not inconsistent with the tradition, so strongly represented by the Greeks, that the Persians were tributary to the Medes. To leave the government of subject nations in the hands of native kings was the rule in the later centuries of the Assyrian empire, and the Medes may well have practised the same policy. It was sufficient that the vassal king sent his yearly tribute, and, on proper occasion, kissed the foot of his master; but further than this was not required, and he was regarded as king in his own tribe or nation.

A word as to Anšan and Anzan. These are geographical terms, — the first a city; the second apparently a land, because preceded by the sign for a country. But since this sign often represents a city also, it may well be that Ansan and Anzan are only two different ways of writing the name of the same place. This seems to be also the opinion of Professor Sayce (*Trans. soc. bibl. arch.*, iii. 475). Probably there was both a city and a country Anšan, or Anzan. But what was Anšan? In the same inscription Cyrus calls himself king of Anšan and king of Persia (Parsu, *Trans. soc. bibl. arch.*, vii. 155, 159). Possibly Anšan, or Anzan, was originally the name of a tribe, city, and district, to which Cyrus and his family belonged.

Another temple which Nabonidus restores is the celebrated temple of the Sun-god at Sippar. Nebuchadnezzar, he relates, had restored this edifice, and had sought for cylinders, but without success. But Nabonidus was determined to find the inscription of the founder of the temple; and his search was rewarded, for, at a depth of eighteen cubits, he came across the cylinder of Naram-Sin, son of Sargon, which no king preceding him had seen for 'three thousand two hundred years.' According to the custom of the kings, he placed an inscription of his own by the side of that of Naram-Sin. As the date of Nabonidus was about 550 B.C., that of Naram-Sin would go back to 3750 B.C. But even at this time civilization must have been far advanced, for Sargon, the father of Naram-Sin (if the same as the Sargon of Agane), had in his library an astronomical work comprising seventy tablets. With this ancient date would agree the statement of Sargon II., king of Assyria 721-705 B.C., that three hundred and fifty princes had preceded him on the throne (Cylinder inscription, l. 45), and the long list of Babylonian kings, numbering, before the tablet was broken, two hundred or more.

A third temple, which Nabonidus restores, is that of the goddess Anunit at Sippar. By digging he found the inscription of the last king who had restored the temple, *Šaggašti-Burtaš*, son of *Kudûi-Bêl*, about 1050 B.C. Anunit, goddess of this temple, seems to be the planet Venus as morning and as evening star.

These two celebrated temples at Sippar are mentioned several times in the cuneiform literature. From Berosus, also, we know that the people of Sippar were devoted to the worship of the sun, for he calls the place 'city of the sun' (ἐν πόλει ἡλίου Σιππάροις). It was also, no doubt, as a part of this worship that the people of Sippar, whom the Assyrian king settled in the land of Samaria, burned their children in the fire (2 Kings, xvii. 31). D. G. LYON.

OCEAN WATER AND BOTTOMS.

THE ocean explored by the Norske Nordhavs expedition, 1876–78, was a part of the North Atlantic lying to the west and north of Norway. The sea-water was especially studied in order to ascertain, if possible, whether the relation subsisting between its

component parts varies sufficiently to admit of determining its fluctuations by the most exact analytical methods, and whether, in that case, it were possible to deduce some definite rule regarding them.

As the result of the analyses, L. Schmelck concludes, "The hypothesis which assumes the ocean to consist throughout its entire depth of one homogeneous fluid, in which the most accurate of chemical analyses shall fail to detect dissimilarity of composition, has received from the experiments here described probably stronger confirmation than from any that have gone before them." Some of the most interesting results are tabulated as follows, the first table showing the mean amounts of certain substances in sea-water at various depths, and the second showing the same for different parallels of latitude: —

I.

	Surface.	Bottom.	Intermediate depths.	Mean value.
Specific gravity	1.0265	1.0265	1.0266	1.0265
Chlorine	1.930	1.933	1.934	1.932
Calcium oxide	0.0576	0.0581	0.0577	0.0578
Magnesium oxide	0.2205	0.2207	0.2200	0.2203
Sulphuric oxide	0.2211	0.2208	0.2223	0.2214

II.

	80°-71°.	71°-66°.	66°-62°.
Specific gravity	1.0264	1.0265	1.0268
Chlorine	1.929	1.937	–
Calcium oxide	0.0580	0.0579	0.0577
Magnesium oxide	0.2190	0 2219	0.2205
Sulphuric oxide	0.2208	0.2210	0.2223

The mean value of the salts occurring in sea-water is given as follows: —

$CaCO_3$,	$CaSO_4$,	$MgSO_4$,	$MgCl_2$,	KCl,	$NaHCO_3$,	NCl.
0.002,	0.1395,	0.2071,	0.3561,	0.0747,	0.0166,	2.682.

Hence 100 parts of dry sea-salt contain —

$CaCO_3$,	$CaSO_4$,	$MgSO_4$,	$MgCl_2$,	KCl,	$NaCO_3$,	NaCl.
0.057,	4.00,	5.93,	10.20,	2.14,	0.475,	76.84.

The ocean-bottom studied is especially interesting from the amount of present and past volcanic and glacial activity in the lands surrounding it. Here, as elsewhere, depth was found to be the principal factor in determining the character of the deposits. Along the coasts of Norway and Spitzbergen, generally at a less depth than five hundred fathoms, the bottom was found to be covered with a more or less plastic gray clay. Its coarseness or fineness varies considerably; and grains of quartz, as a rule with rounded edges, constitute the chief portion of the mineral particles in it. At the approximate depth of from five hundred to a thousand fathoms, a brown clay is found, forming a transition from the gray clay to the true oceanic deposits.

At nearly all depths below a thousand fathoms, and oftentimes at less depths, is a fine light to dark brown colored deposit containing minute white shells of the genus Biloculina, in size and shape like a pin-head. This shell gives name to the clay, which corresponds approximately to the Globigerina ooze of the Challenger expedition. The ground is taken, that the power of sea-water to dissolve the carbonate of lime of the foraminiferal shells is not owing to the greater amount of carbonic acid at great depths in the ocean; for the observations of Mr. Tornøe showed that the sea-water invariably reacted as an alkali, and hence the carbonic acid could not be free. Again: the latter was found to be about the same in the depths of the ocean as on the surface; while the general uniformity of composition of the sea-water, as shown by numerous investigations, renders it improbable that any deviation in amount of carbonic acid occurs; hence the power possessed by sea-water to dissolve carbonate of lime does not depend upon the greater or less proportion of free carbonic acid.

The bottom of the shallow ocean between Norway, Beeren Eiland, Spitzbergen, and Novaia Zemlaia, was found to be covered with a greenish-gray clay containing but few animal remains. Minute and generally sharp-edged quartz grains were the principal constituent. This deposit was termed the Rhabdammina clay, from a genus of Foraminifera which often abounds in that part of the ocean-bed. This clay, according to Schmelck, originates from the 'decomposition of quartzitic rocks,' especially those of Beeren Eiland.

Off the volcanic island of Jan Mayen, above the six-hundred-fathom line, occurs a deposit of dark-gray sand, and sabulous clay containing fragments of basaltic lava, olivine, augite, etc., which seem to have been derived from the volcanic *débris* of the island.

An important fact bearing on the question of the distribution of *débris* by bottom-currents in the ocean is the statement that "all samples of water brought up from the bottom were perfectly clear, without a trace of floating particles."

The occurrence of numerous stones and pebbles on the sea-floor, as well as not uncommonly a rocky bottom, is of interest. The pebbles decrease in size and number in going from the shore towards deep water. While rare in the deep water south of the 72d parallel, they are quite common in that to the west of Spitzbergen and Beeren Eiland, where drift-ice abounds. Out of three hundred and seventy-five stations, pebbles and fragments of minerals and rocks were dredged at a hundred and twenty-three of them, while at many others no sample of the bottom could be obtained on account of its rocky condition. Of especial interest is the finding of numerous fragments of flint and chalk, a fossil (belemnite) from the chalk, fragments of coal, and some striated stones. Other pebbles and fragments found were marble, limestone, granite of various kinds, sandstone, argillite, quartzite, flint, chalk, granitic veinstone, quartz porphyry, gabbro, basalt, pumice, amygdaloidal rocks; chloritic, hornblendic, quartz, mica, and other crystalline schists; calcite, quartz, mica, hornblende, felspar, asbestos, coal, olivine, augite, coral, shells of various kinds, rotten wood, etc.

Schmelck concludes that organic agency is a subordinate factor in the formation of the floor-deposits

of the northern ocean, as is volcanic *débris*, but that the chief portion of the material consists of the solid matter carried out to sea by drift-ice and glacial rivers. M. E. WADSWORTH.

THE NATURAL HISTORY OF IMPLEMENTS.[1]

"WHEN will hearing be like seeing?" says the Persian proverb. Words of description will never give the grasp that the mind takes through actual sight and handling of objects; and this is why, in fixing and forming ideas of civilization, a museum is so necessary. One understands the function of such a museum the better for knowing how the remarkable collection formed by Gen. Pitt-Rivers came into existence. About 1851 its collector, then Col. Lane Fox, was serving on a military sub-committee to examine improvements in small arms. In those days the British army was still armed (except special riflemen) with the old smooth-bore percussion musket, the well-known 'Brown Bess.' The improved weapons of continental armies had brought on the question of reform; but the task of this committee of juniors to press changes on the heads of the service was not an easy one, even when the Duke of Wellington, at last convinced by actual trial at the butts, decreed that he would have every man in the army armed with a rifle-musket. Col. Fox was no mere theorist, but a practical man, who knew what to do and how to do it; and his place in the history of the destructive machinery of war is marked by his having been the originator and first instructor of the School of musketry at Hythe. While engaged in this work of improving weapons, his experience led his thoughts into a new channel. It was forced upon him that stubbornly fixed military habit could not accept progress by leaps and bounds, only by small partial changes, an alteration of the form of the bullet here, then a slight change in the grooving of the barrel; and so on, till a succession of these small changes gradually transformed a weapon of low organization into a higher one, while the disappearance of the intermediate steps, as they were superseded, left apparent gaps in the stages of the invention,—gaps which those who had followed its actual course knew to have been really filled up by a series of intermediate stages. These stages Col. Lane Fox collected and arranged in their actual order of development, and thereupon there grew up in his mind the idea that such had been the general course of development of arts among mankind. He set himself to collect weapons and other implements till the walls of his house were covered from cellar to attic with series of spears, boomerangs, bows, and other instruments, so grouped as to show the probable history of their development. After a while this expanded far beyond the limits of a private collection, and grew into his museum. There the student may observe in the actual specimens the transitions by which the parrying-stick, used in Australia and elsewhere to ward off spears, must have passed into the shield. It is remarkable that one of the forms of shield which lasted on latest into modern times had not passed into a mere screen, but was still, so to speak, fenced with. This was the target carried by the Highland regiments in the low countries in 1747. In this museum, again, are shown the series of changes through which the rudest protection of the warrior by the hides of animals led on to elaborate suits of plate and chain armor. The principles which are true of the development of weapons are not less applicable to peaceful instruments, whose history is illustrated in this collection. It is seen how (as was pointed out by the late Carl Engel) the primitive stringed instrument was the hunter's bow, furnished afterwards with a gourd to strengthen the tone by resonance, till at last the hollow resonator came to be formed in the body of the instrument, as in the harp or violin. Thus the hookah or nargileh still keeps something of the shape of the cocoanut-shell, from which it was originally made, and is still called after (Persian, *nárjíl* = cocoanut). But why describe more of these lines of development when the very point of the argument is that verbal description fails to do them justice, and that really to understand them they ought to be followed in the series of actual specimens? All who have been initiated into the principle of development or modified sequence know how admirable a training the study of these tangible things is for the study of other branches of human history, where intermediate stages have more often disappeared, and therefore trained skill and judgment are the more needed to guide the imagination of the student in reconstructing the course along which art and science, morals and government, have moved since they began, and will continue to move in the future.

[1] Extract from a lecture on anthropology, delivered Feb. 21, at the University museum, Oxford, by E. B. TYLOR, D.C.L., F.R.S. From *Nature* of May 17.

THE INTELLIGENCE OF THE AMERICAN TURRET SPIDER.

AT the meeting of the Academy of natural sciences of Philadelphia, June 19, Rev. Henry C. McCook exhibited nests of Tarentula arenicola Scudder,—a species of ground spider of the family Lycosidae, properly known as the turret spider. The nests in natural site are surmounted by structures which quite closely resemble miniature old-fashioned chimneys composed of mud and crossed sticks, as seen in the log cabins of pioneer settlers. From half an inch to one inch of the tube projects above ground, while it extends straight downward twelve or more inches into the earth. The projecting portion, or turret, is in the form of a pentagon, more or less regular, and is built up of bits of grass, stalks of straw, small twigs, etc., laid across each other at the corners. The upper or projecting parts have a thin lining of silk. Taking its position just inside the watch-tower, the spider leaps out, and captures such insects as may come in its way. Nests had been found at the base of the Alleghany Mountains

near Altoona, and in New Jersey on the seashore. In the latter location the animal had availed itself of the building-material at hand by forming the foundation of its watch-tower of little quartz pebbles, sometimes producing a structure of considerable beauty. In this sandy site the tube is preserved intact by a delicate secretion of silk, to which the particles of sand adhere. This secretion scarcely presents the character of a web-lining, but has sufficient consistency to hold aloft a frail cylinder of sand when it is carefully freed from its surroundings. A nest recently obtained from Vineland, N.J., furnished an interesting illustration of the power of these araneids to intelligently adapt themselves to varying surroundings, and to take advantage of circumstances with which they certainly could not have been previously familiar. In order to preserve the nest with a view to study the life-history of its occupant, the sod containing the tube had been carefully dug up, and the upper and lower openings plugged with cotton. Upon the arrival of the nest in Philadelphia, the plug guarding the entrance had been removed; but the other had been forgotten, and allowed to remain. The spider, which still inhabited the tube, immediately began removing the cotton at the lower portion, and cast some of it out. Guided, however, apparently by its sense of touch, to the knowledge that the soft fibres of the cotton would be an excellent material with which to line the tube, she speedily began putting it to that use, and had soon spread a soft smooth layer over the inner surface and around the opening. The nest in this condition was exhibited, and showed the interior to be padded for about four inches from the summit of the tower. The very manifest inference was drawn, that the spider must for the first time have come in contact with such a material as cotton, and had immediately utilized its new experience by substituting the soft fibre for the ordinary silken lining, or by adding it thereto.

LETTERS TO THE EDITOR.

Equations of third degree.

THE second or third terms of any equation may be made to disappear, and we may therefore assume

$$x^3 + Ax^2 + B = 0; \qquad (1)$$

and the solution of this equation must involve the general solution of cubics. Assume

$$x = y^{\frac{2}{3}} - y^{\frac{1}{3}}z^{\frac{1}{3}} + z^{\frac{2}{3}}. \qquad (2)$$

Hence

$$y^{\frac{1}{3}} = \sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{1}{2}z^{\frac{1}{3}}.$$

$$y = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{2}xz^{\frac{1}{3}} - z + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$y + z - \tfrac{3}{2}xz^{\frac{1}{3}} = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$z^{\frac{2}{3}} - \frac{y+z}{x}z^{\frac{1}{3}} = \frac{x^3 - (y+z)^2}{3x^2}.$$

$$z^{\frac{1}{3}} = \sqrt{\frac{4x^3 - (y+z)^2}{12x^2}} + \frac{y+z}{2x}.$$

$$z = \sqrt[\frac{3}{2}]{\frac{4x^3 - (y+z)^2}{12x^2}} + \frac{y+z}{2} + \frac{3(y+z)^2}{4x^2}\sqrt{\frac{4x^3 - (y+z)^2}{12x^2}}.$$

$$432x^6(z-y)^2 =$$
$$64x^9 + 240x^6(y+z)^2 + 192x^3(y+z)^4 - 64(y+z)^6.$$

$$x^9 - 3x^6(y+z)^2 + 3x^3(y+z)^4 - (y+z)^6 = -27zyx^6.$$

$$x^3 + 3\sqrt[3]{zy}\,x^2 - (y+z)^2 = 0. \qquad (3)$$

In (1) and (3), equating coefficients,

$$3\sqrt[3]{zy} = A, \quad zy = \frac{A^3}{27}. \qquad (4)$$

$$-(y+z)^2 = B, \quad y^2 + 2yz + z^2 = -B. \qquad (5)$$

Whence, from (4) and (5),

$$y = \sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$

$$z = \sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$

Substituting these values of y and z in (2),

$$x = \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}} - \frac{A}{3} + \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}}, \qquad \text{formula } (a)$$

or

$$x = -\sqrt[3]{\frac{B}{2} + \frac{A^3}{27} - \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}} - \frac{A}{3} - \sqrt[3]{\frac{B}{2} + \frac{A^3}{27} + \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}}. \qquad \text{formula } (b)$$

In the case of the irreducible case of formula (b), which is similar to Cardan's formula, formula (a) may be used. In such case, only one part, as $\sqrt{-\frac{B}{4}}$, of formula (a) is imaginary, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is real; and if the signs of the roots of equation (1) be changed, which is done by changing simultaneously the signs of A and B in equation (1), the converse is true, that is, $\sqrt{-\frac{B}{4}}$ is real, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is imaginary. Which shall be the imaginary term is, then, arbitrarily chosen. Hence, factoring preparatory to expansion by the binomial theorem, the coefficient of $\sqrt{-1}$ may be made less than unity when the real term is unity.

A. M. SAWIN.

Evansville, Wis.

Solar constant.

It is feared that the letter of Mr. Hazen (SCIENCE, i. 542) in relation to above topic may not entirely remove the confusion of which he justly complains. It should be premised that there are two units of heat in common use among physicists: the smaller being the quantity of heat required to raise the temperature of one gram of water 1° C.; the larger, the quantity of heat required to raise the temperature of one kilogram of water 1° C. The larger of these units is a thousand times as great as the smaller; and, in ordinary applications, no confusion is liable to arise. In either case, the number of units of heat received by the unit-mass of water is (sensibly) proportional to the number of degrees of rise of temperature.

With regard to the 'solar constant,' two additional units are required, — a unit of surface, and a unit of time. This constant may be defined in general terms

to be the number of units of sun-heat incident perpendicularly on a unit-surface, in a unit of time, at the upper limit of the earth's atmosphere; or it is the number of degrees Centigrade a unit-mass of water would be raised in temperature by the sun-heat incident perpendicularly on a unit-surface, in a unit of time, at the upper limit of the atmosphere. The three units here indicated are, of course, arbitrary. But most physicists, following the example of Pouillet (*Comptes rendus*, vii. 24), take the gram, square centimetre, and minute, as respectively the units of mass, surface, and time. With regard to time, there is no diversity, the minute being universally used; but, for mass and surface, some employ the larger units of a kilogram and a square metre, and hence the apparent confusion. To obtain a general expression for the value of the 'solar constant,' let

Q = Quantity of sun-heat incident normally on a unit-surface in a unit of time = solar constant.
S = Area of surface receiving the heat.
T = Time of receiving the heat.
m = Unit mass of water.
n = Number of unit masses of water heated.
t° = Rise in temperature of the mass of water.

Then we have

$$Q \times S \times T = n \times m \times t^\circ.$$

Consequently, when S, T, and n are severally equal to unity, we have $Q = m \times t^\circ$; and, when $m = 1$, $Q = t^\circ$ = rise in temperature of a unit-mass of water = value of solar constant in units of heat.

Now, when the unit of time remains the same, but the units of mass and surface are changed, the value of t° (which measures the solar constant) will be altered, unless both of these units are changed in the same ratio. For, from the equation $Q = m \times t^\circ$, it follows that t° varies as $\frac{Q}{m}$; but evidently Q is proportional to the magnitude of the unit of surface: hence t° varies as $\frac{\text{unit of surface}}{\text{unit of mass of water}}$.

For example: using Pouillet's units, Langley's recent experiments make the solar constant = 2.84; that is, the sun-heat incident normally on one square centimetre, in one minute, at the upper limit of the atmosphere, would raise the temperature of one gram of water 2.84° C., or would heat 2.84 grams of water 1° C. Now, the unit remaining the same, if we assume the unit of mass to be one kilogram (1,000 grams), and the unit of surface to be one square metre (10,000 square centimetres), we should have the value of the constant $t'^\circ = \frac{10,000}{1,000} \times 2.84 = 28.4$ kilogram-units of heat; that is, the sun-heat incident normally on one square metre, in one minute, at the upper limit of the atmosphere, would raise the temperature of one kilogram of water 28.4° C., or would heat 28.4 kilograms of water 1° C.

Moreover, as it requires a definite number of units of heat to liquefy a unit-mass of ice, or to evaporate a unit-mass of water, or to produce a unit of mechanical energy, it follows that this constant may be measured by either of these units.

The exact determination of the value of this constant is a most refined and difficult experimental problem; for it involves the precise estimation of the amount of solar heat absorbed in traversing the earth's atmosphere, or the law of extinction of sun-heat in passing through it: hence it is, that, although several excellent physical experimenters have attacked the problem, their results are not so accordant as would be desirable. The following are some of the results:—

Experimenter.	Date.	Solar constant.	
		Gram-units of heat per square centimetre per minute.	Kilogram-units of heat per square metre per minute.
Pouillet . .	1838	1.7633	17.633
Forbes . .	1842	2.847	28.47
Crova . . .	1876	2.323	23.23
Violle . . .	1876	2.540	25.40
Langley . .	1882	2.840	28.40

JOHN LECONTE.

Berkeley, Cal., June 25, 1883.

WARD'S DYNAMIC SOCIOLOGY.

Dynamic sociology, or applied social science, as based upon statical sociology and the less complex sciences. By LESTER F. WARD, A.M. 2 vols. New York, *Appleton*, 1883. 20+706; 7+690 p. 8°.

I.

THIS work of Mr. Ward is composed of two distinct parts. The first gives the outlines of his philosophy, as a basis for his reasoning in the one that follows. The second is a discussion of the causes and consequences of progress, or evolution, in human society. For some purposes it would have been wise to give each part a distinct title, reserving for the last part the one used; but the philosophic system propounded in the first part has evidently been prepared as a basis for the second, and in itself would not be considered by the author as a complete exhibit of his philosophy.

Vol. i. contains: first, an outline of the work, in which the author's purposes are clearly set forth; second, an historical review, chiefly devoted to a discussion of the philosophies of August Comte and Herbert Spencer; third, the cosmic principles underlying social phenomena, in which the outlines of the new system are set forth. Under the general title of 'primary aggregation,' he discusses the constitution of celestial bodies and chemical relations. Under that of 'secondary aggregation,' he discusses biology, psychology, and the genesis of man. Under that of 'tertiary aggregation,' he discusses the genesis of society and the characteristics of social organization. The purpose of this preliminary volume on general philosophy, and of the introduction to the second volume, is tersely given by Mr Ward himself, as follows:—

"The purpose of the present chapter [chap. viii.], as already announced, has been to accomplish the complete orientation of

the reader for the voyage before him. Without this, much that is to come might appear meaningless, or at least lose its point.

"Men think in systems. Most systematic treatises are unintelligible unless followed from the beginning and grasped in their entirety. A fundamental tone runs through them which prescribes the special sense of every line, and which is wholly unheard in isolated passages. The careful reader of such works, without necessarily acquiescing in the author's views, is able at least to comprehend them and to do justice to them." . . .

"In the following argument, now to be briefly stated, and subsequently to be fully elaborated, the statements made in this chapter, as well as those contained in the preceding volume, are to be taken as the basis, or premises, and must be granted 'for the sake of the argument' at least, however unsound they may be deemed in themselves."

Elsewhere the theory is more fully elaborated, that the more complex sciences can be grasped only as the more simple sciences upon which they are based are properly understood, and that anthropologic sciences in general must rest firmly upon physics and biology. Though the reader may differ from Mr. Ward in relation to his classification and conclusions, he will still be interested in the symmetry of his system and the perspicuity of his presentation.

The essential principle running through the treatise is, that progress in society is based upon the struggle for happiness in the same manner as biologic progress is based upon the struggle for existence. It is therefore a new system, in radical contrast with that taught in our schools and enunciated by the majority of publicists of the present day, of whom Herbert Spencer is the chief. For this struggle for happiness the term 'conation' (*conari*, to endeavor) is used, taken from Sir William Hamilton; and he says, "The term 'conation' will be employed in this work to represent the efforts which organisms put forth in seeking the satisfaction of their desires, and the ends thus sought will be designated as the 'ends of conation.'"

Again, the author classifies phenomena as *genetic* and *teleologic*. Genetic phenomena are such as appear in series, with natural antecedents and consequents, unaffected by design or purpose. Teleologic phenomena do not appear in natural series, the antecedents being physical phenomena controlled by design existing in mind, and the consequents being the purposes for which the will is exercised. Throughout the work these two classes of phenomena are clearly distinguished; but it is impossible, in a brief review, to set forth fully the importance of the distinction, as the author himself has done. In general terms, it may be stated that biologic progress is due to the struggle for existence, and involves genetic phenomena; while sociologic progress is due to the struggle for happiness (conation), and involves teleologic phenomena.

"All progress is brought about by *adaptation*. Whatever view we may take of the cause of progress, it must be the result of a correspondence between the organism and the changed environment. This, in its widest sense, is adaptation. But adaptation is of two kinds. One form of adaptation is *passive* or *consensual*, the other form is *active* or *previsional*. The former represents *natural* progress, the latter *artificial* progress. The former results in a *growth*, the latter in a *manufacture*. The one is the *genetic* process, the other the *teleological* process. In passive adaptation the means and the end are in immediate proximity, the variation takes place by infinitesimal differences; it is a process of *differentiation*. In active adaptation, on the contrary, the end is remote from the means; the latter are adjusted to secure the former by the exercise of *foresight;* it is a process of *calculation*."

By the term 'dynamic sociology,' as used by the author, is to be understood a systematic treatise on the forces which impel mankind into social relations, to develop social organization, and to provide and modify the institutions of society. The subject-matter of dynamic sociology, appearing in the second volume, is arranged in the following order, as set forth by the author: —

"The remainder of this work will chiefly consist in the discussion of six terms; and therefore, before entering upon such discussion, it is a primary necessity to furnish rigid definitions of each of these terms.

"For a purpose which will presently appear, we will assign to each of these terms a letter, which will fix their order in a series not admitting of any alteration.

"The first of these terms, which we will designate by the letter A, is *happiness;* the second, which we will designate by B, is *progress;* the third, which we will designate by C, is *dynamic action;* the fourth, which we will designate by D, is *dynamic opinion;* the fifth, which we will designate by E, is *knowledge;* and the sixth, which we will designate by F, is *education*.

"The definitions of these six terms are as follows:

"A. Happiness. — Excess of pleasure, or enjoyment, over pain, or discomfort.

"B. Progress. — Success in harmonizing natural phenomena with human advantage.

"C. Dynamic action. — Employment of the intellectual, inventive, or indirect method of conation.

"D. Dynamic opinion. — Correct views of the relations of man to the universe.

"E. Knowledge. — Acquaintance with the environment.

"F. Education. — Universal distribution of extant knowledge.

"Corresponding to these six terms thus defined, there are six theorems of dynamic sociology, which require to be elaborated and established, and to each of which a separate chapter will be devoted.

"Continuing the literal designations, these theorems are the following: —

"A. Happiness is the ultimate end of conation.

"B. Progress is the direct means to happiness; it is, therefore, the first proximate end of conation, or primary means to the ultimate end.

"C. Dynamic action is the direct means to progress; it is, therefore, the second proximate end of conation, or secondary means to the ultimate end.

"D. Dynamic opinion is the direct means to dynamic action; it is, therefore, the third proximate end of conation, or tertiary means to the ultimate end.

"E. Knowledge is the direct means to dynamic opinion; it is, therefore, the fourth proximate end of conation, or fourth means to the ultimate end.

"F. Education is the direct means to knowledge; it is, therefore, the fifth proximate end of conation, and is the fifth and initial means to the ultimate end."

The remaining six chapters of the work, namely, chapters ix., x., xi., xii., xiii., xiv., treat of these six subjects *seriatim*.

In chapter ix., then, the doctrine is set forth that happiness is the ultimate end of conation, or human endeavor. Here Mr. Ward discusses the nature and genesis of feeling, as the proper basis of a philosophic system involving the interests of man; and he subsequently endeavors to show, that, what function is to biology, feeling is to sociology. And after a discussion of the intellectual method as compared with the physical method of conation, and several collateral subjects, he sets forth the doctrine that degree of feeling is concomitant with degree of organization, and that the pursuit of happiness by man leads to higher physical, mental, and social organization; that, in turn, such higher organization increases feeling, and thus increases pleasure, and thus increases happiness.

Chapter x. is devoted to the consideration of progress as the primary means to happiness, and includes: a discussion of the difference between dynamic sociology and moral science; then a discussion of the growth of the means for communicating ideas, — language in all its forms; then of the arts and industries which are developed in the pursuit of subsistence; then the origin of government and the institutions of government; and, finally, the origin and institutions of religion.

Chapter xi. is entitled 'Action,' — a term chosen in preference to the more common expression, *conduct*. The chapter is chiefly devoted to the discussion of a systematic classification of actions, first, as involuntary and voluntary; and voluntary actions are again divided into impulsive or sensori-motor, and deliberative or ideo-motor. Each of the latter classes consists of two groups; namely, actions possessing moral quality, and actions devoid of moral quality.

It is no part of the author's purpose to treat of action possessing moral quality; although, in order to make clear the irrelevancy of such actions to his discussion, he occupies some space in going over the ground usually covered by writers on ethics. Actions devoid of moral quality are those upon which progress essentially depends, and chiefly that branch which falls under the more general head of deliberative or ideo-motor actions. They are further subdivided into static and dynamic, the former group embracing the great bulk of human activities in the performance of the ordinary duties of life. Static actions of this class do not result in progress, but tend simply to preserve the existing social status. Dynamic actions constitute the really progressive class of actions.

The chief fact which distinguishes dynamic actions from all others is, that they are performed by the indirect or inventive method. All the progress that has taken place in society has been due to such action. However spontaneous such progress may appear, it has, nevertheless, been the result of teleologic methods in adjusting natural phenomena in such a manner that they will accomplish desired ends, — remote in themselves, but foreseen by the intelligence of the developing intellect. The results are the essential elements of human

art; and consequently civilization is fundamentally and wholly artificial. Here Mr. Ward introduces a series of illustrations of typical dynamic actions performed in the course of social progress, for the purpose of elucidating the central idea which he desires to embody in the term 'dynamic action.'

Chapter xii. is a discussion of opinion as the direct means to progressive action. As dynamic actions are ideo-motor, such actions must result from the possession by the agent of certain underlying and directing ideas. The truism that 'ideas rule the world' simply means, that opinions determine actions. But in order to produce dynamic actions, — that is, actions which will, in fact, result in progress, — it is essential that the opinions which underlie them be in rigid harmony with objective reality. Dynamic action can only flow from correct opinion.

Opinions must not only be correct, they must be important. Unless important, no appreciable dynamic result will flow therefrom. The most important opinions, or ideas, are arranged under four general heads: first, cosmologic ideas; second, biologic ideas; third, anthropologic ideas; fourth, sociologic ideas. Correct ideas belonging to these four great classes constitute the primary motive power to all human progress.

Chapter xiii. is upon knowledge, — the immediate data of ideas. Opinions cannot be directly reached. They are not subject to the will, either of the party holding them or of any other: they are simply consequents. Obviously, the antecedents of ideas consist in the data possessed by the mind relative to the materials and phenomena of nature. Such data are grouped by the author under the general term 'knowledge.' Knowledge, therefore, must first exist; and, if it exist, no effort need be expended in determining opinion. In this chapter the author shows that the chasm which in fact separates the intelligence of the lowest and the highest classes of mankind is chiefly due to inequality in the possession of the data for thought. He shows that the capacity of the mind is, in any particular class of society, practically equal; that, even in what are known as semi-civilized or barbaric races, the capacity exists for a far greater amount of knowledge than is ever obtained.

Chapter xiv. is on education as the direct means to knowledge. The possession of knowledge, therefore, if it could be secured, would constitute the true means to the proximate end, and thus secure the ultimate purpose. But the human mind is so constituted that it cannot be safely intrusted to secure this end for itself; for the individual cannot understand the necessity for this knowledge, or guide himself wisely in its attainment, prior to its acquisition: that is, the period of acquisition is in the earlier years of the life of the individual, when he must be guided by others. The initial means in the entire series is therefore education, actively considered as a function of society.

The work closes with a condensed but fundamental treatment of the general subject of popular education, in which appears a review of the various theories that have been held, and that still control human action on this subject. He divides the general body of public opinion into five parts, which he denominates 'the five kinds of education.' These are: first, education of experience; second, of discipline; third, of culture; fourth, of research; fifth, of information. The first four of these kinds of education are considered for the purpose of showing, that, however important in themselves, they are insufficient to accomplish the great end of securing an artificial civilization as the product of direct social action. The last of these forms of education, therefore, is the only one which embodies such promise.

The author sees little hope in the imperfect and desultory attempts of individuals to secure this great need in society. To render it of any value, he claims that education must be the systematic work of society in its organized capacity. Ceasing to exert itself longer in vain attempts to secure directly the various proximate ends, society should vigorously adopt this inital means, and concentrate its energies on the work which is clearly practicable, — that of furnishing to all its members the data actually in its possession.

Under the heading 'Matter of education' the author briefly, but without dogmatism, discusses the general theorem that the subject-matter should be a knowledge of nature, — a knowledge of the environment of the individual and of mankind. His treatment of the methods of popular instruction is brief, maintaining that this is merely a matter of supply in the politico-economic sense, which will certainly come as soon as there shall be an adequate demand. He says, "The methods and the teachers have always been as good as the popular notions of education, and they will doubtless continue to be so." The only criterion which he does lay down with regard to method is that it be teleologic. He insists that education, like every other department of civilization, must be an artificial product; that it

must be undertaken deliberately, planned by human intelligence, and achieved through human effort.

The author discusses, in a broad and philosophic manner, a great body of questions in which civilized man is deeply interested. He has therefore written for a wide reading; and happily his style, in its essential characteristics, will not repel those to whom it is presented.

GEOLOGY OF SOUTHERN PENNSYLVANIA.

Second geological survey of Pennsylvania. — Report of progress T^2. — *The geology of Bedford and Fulton counties.* By J. J. STEVENSON. Harrisburg, *Survey*, 1882. 15+382 p., 2 maps. 8°.

PROFESSOR STEVENSON has made a detailed survey of the district, which has led to but few material changes in the map of the first survey. The descriptions of the structural geology are careful, plain, and easily understood; and the second part of the report, consisting of a day-book of observations along the roads, with reference to outcrops, mines, and quarries, will doubtless prove very useful.

It is well that Professor Stevenson has not completely neglected paleontology in his descriptions of the various formations; but this feature of his report is capable of much improvement, only about sixty species being cited as occurring in a section that extends from the upper coal-measures to the calciferous. The value of his determinations, and the scientific interest of his work, would have been much increased, if care had been taken to collect and determine the fossils found in each group, and lists of them published, together with the localities in which they occurred. It is not meant to infer that Professor Stevenson's determinations are incorrect, but simply that he gives no evidence in support of them. For instance: he says, "Some of these layers contain fossils which are *distinctly Chemung*, none whatever of Portage type being present; but, owing to the weathering, the forms can be identified only generically." The writer does not think he is alone in doubting whether there are any fossils which are distinctively Chemung. At any rate, it would be interesting to know what these genera are. He mentions no fossils in his Hudson River group, and in the Trenton mentions only three forms, which are also very common at the top of the lower Silurian. The director of the survey, in his letter of transmittal, makes the following curious remark, which seems to indicate a peculiar conception of the objects of paleontology. He says, "Paleontologists will find it an easy task to copy out from the index, separately, the whole list of fossil names, and arrange them afterwards to suit their own purposes." Certainly, paleontologists do not want to arrange fossils to suit themselves, but to find out how nature has arranged them. The two maps accompanying the report are of very indifferent quality, as it is difficult, especially over the Broad Top area, to follow on the maps the descriptions in the text. Mr. Stevenson disclaims responsibility for several things in them, which may account for the discrepancies between the text and the maps. Professor Lesley seems to think that the maps may be easily followed by a person familiar with the country; but the maps should have been constructed so that others, also, may be able to understand them. He seems to apply preconceived notions of orography, whether it agrees with the geology as studied in the field or not; and, if the responsibility of preparing the maps rested with the same person who has done the field-work and prepared the text, the result would probably be more intelligible. Mr. Stevenson mentions a bed 195 feet above the Pittsburg coal. This would apparently belong to the upper series, considered Permian in other reports of the survey; but this does not appear to be represented anywhere on the map.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Eclipses of Jupiter's satellites. — Cornu proposes to observe these eclipses photometrically, comparing the light of the satellite during the time while it is entering or emerging from the shadow with that of an artificial satellite visible in the same field, and made to vary in brightness at pleasure by an adjustable 'cat's eye,' so called. He shows that the moment when the light of the satellite is *half* that of its unobscured condition is the one which can be most accurately determined, and urges that the photometric observations should be so arranged as to give an automatic record. Admiral Mouchez has authorized the application of the necessary apparatus to one of the large equatorials of the Paris observatory.

M. Cornu does not seem to be aware that a very similar, but really more precise, method of observa-

tion has been in use at the Harvard college observatory for the past two years. Prof. Pickering, however, very wisely prefers to compare the eclipsing satellite with one of the other satellites, or with an image of the planet, rather than with an artificial star; and he uses polarization apparatus instead of a cat's eye to equalize the brightness of the objects compared. — (*Comptes rendus*, June 4.) C. A. Y. [40

MATHEMATICS.

Theory of functions. — In a series of three memoirs, M. Appell has reproduced in a more extended form a number of investigations which he has recently communicated to the French academy of sciences. The first of the three memoirs treats of uniform functions of an analytical point (x, y); the term 'analytical point' meaning simply the system of values of (x, y) formed by any arbitrary value of x and the, say, m corresponding values of y. The first section of the memoir contains three theorems concerning the development in rational fractions of such functions. In the second section a uniform function is defined, and also the poles and essential singular points (*points singuliers essentiels*, Weierstrass' *wesentliche singuläre stelle*). Functions with a finite number of singular points are then taken up, and a generalization of a known theorem concerning the coefficients in the development of a uniform function is given: viz., if $F(x, y)$ is a uniform function of the analytical point (x, y), having a finite number of singular points (a_i, b_i), and if R_i are the residues relatively to these points; if, further, in a certain region of the analytical point $\left(x = \infty, \ \lim \frac{y}{x} = C_k\right)$, we have $F(x, y) = \sum_{\nu=-\infty}^{\nu=\infty} A_\nu^{(k)} \frac{1}{x^\nu}$, — then we have the relation

$$A_1^{(1)} + A_1^{(2)} + \ldots + A_1^{(m)} = R_1 + R_2 + \ldots + R_n.$$

In this, i has all values from 1 up to n, and k has all values from 1 up to m; m denoting the number of values of y corresponding to a given value of x. After a brief review of some of the properties of the Abelian integrals, the author gives a generalization of a holomorphic function of x in the interior of a circle whose centre is a in terms of ascending powers of $(x - a)$. The subject of functions with an infinite number of singular points is then taken up, and a generalization is first given of Mittag-Zeffler's theorem concerning these functions; viz., if a series of distinct analytical points $(a_1, b_1) \ldots (a_\nu, b_\nu) \ldots$ are such that $\lim (a_\nu, b_\nu) = (a\ b)$ for $\nu = \infty$, and if $F_1(x, y), F_2(x, y) \ldots F_\nu(x, y)$ is a series of rational functions of x and y which become infinite only in the two points (a_ν, b_ν) and (a, b) respectively, then there exists a uniform function $\Phi(x, y)$ having only the point (a, b) as an essential singular point, and admitting as poles the points (a_ν, b_ν) in such a manner that the difference $\Phi(x, y) - F_\nu(x, y)$ is regular in the point (a_ν, b_ν).

The second memoir by M. Appell is a continuation of the first. In it he considers the decomposition into prime factors of a uniform function of an analytical point (x, y) having only one essential singular point, and also gives a theory of doubly periodic functions with essential singular points. The author examines, first, functions having in a parallelogram of periods a finite number of singular points, and gives an interesting theorem; viz., the sum of the residues of $F(u)$ relative to the singular points situated in a given parallelogram of periods is equal to zero. A general expression is then obtained for a doubly periodic uniform function $F(u)$ having in a given parallelogram of periods only one singular point.

In the third memoir, M. Appell considers the development of functions in series inside an area bounded by arcs of circles. These three memoirs by M. Appell, taken with a memoir by M. Poincaré, which precedes them, and which has already been referred to in these pages, constitute a very valuable series of papers on the modern theory of functions. — (*Acta math.*, i. no. 2.) T. C. [41

PHYSICS.

Acoustics.

Upper limit of audibility. — Pauchon and Bertrand have investigated the question of the effect of the intensity of the sound upon this limit. A siren blown by steam with pressures varying from 0.5 to 1.5 atmospheres gave from 24,000 to 30,000 double vibrations as a limit; but, with certain modifications and a higher pressure ($2\frac{1}{2}$ atmospheres), the most acute sound that could be produced by the instrument, due to 36,000 vibrations, was still heard. Metallic rods of different lengths, set into longitudinal vibration in the usual manner, gave the following results: 1. The length of the rod giving the highest perceptible sound is independent of its diameter; 2. For steel, copper, and silver, the lengths are proportional to the velocity of sound in those media. These results disagree with those reached with the siren. The authors find, however, that, if the ear is aided by a resonating trumpet, the limit is slightly raised; that the limit is raised with substances like rosin, producing the most energetic friction; and that the sound, even when too high to affect the ear, still acts on a sensitive flame.

These results of Pauchon with the siren agree with the fact observed several years since by Dr. H. P. Bowditch of Boston, that, with a König's bar of exceedingly large diameter, the limit of audibility is higher than with one of the ordinary size. — (*Comptes rendus*, April 9.) C. R. C. [42

Production of whispered vowels. — Lefort calls attention to the wide range of whispered vowels that can be artificially produced by blowing across resonant tubes or spheres: *ou*, *o* (closed), *o* (open), *u*, *eu*, *e*, *i*, *é* (closed), *é* (open), — all being produced as the capacity of the resonator is diminished. By diminishing the length of an open tube the vowels *â*, *à*, *e*, *eu*, *u*, *è*, *é*, *i*, are successively heard, while *ou*, *ô*, *o*, are obtained by closing the upper end of the tube more or less. — (*Comptes rendus*, April 23.) C. R. C. [43

Transmission of sounds by gases. — Neyreneuf has studied the relative transmission of sound

through air, carbonic oxide, carbonic acid, and illuminating-gas. The sound is transmitted through a tube two metres long, containing the gas experimented upon, and the intensity is studied by noticing the distance at which a sensitive flame ceases to be acted upon by it. He finds that air and carbonic oxide have the same transmissive power, air and illuminating-gas give very variable results, and carbonic acid has a much greater transmissive power than air. A table of results for air and carbonic acid is given. — (*Comptes rendus*, April 30.) C. R. C. [44

Experimental demonstration of velocity of sound. — Griveaux arranges a glass tube and a bar of pine wood of equal length, so that the passage of a pulse through either the column of air in the tube or the wooden rod shall move one of two light screws, and so break an electric contact. The current from a battery is divided, and passes into the two coils of a differential galvanometer; the light screw resting on the end of the rod being placed in one circuit, and a similar screw, resting on a membrane closing the end of the tube, in the other. The resistances are so arranged that the needle of the differential galvanometer remains normally undeflected. If a sound is produced by striking a drum, the needle of the galvanometer is deflected in such a direction as to show that the contact is broken by the movement of that screw resting on the end of the wooden rod, thus illustrating the greater velocity of the sound-wave in wood than in air. — (*Journ. phys.*, May.) C. R. C. [45

ENGINEERING.

Electric stop for steam-engines. — Mr. Tate, an English engineer, has combined the Leclanché battery, an electro-magnet, an auxiliary steam-cylinder, and a stop, to the closing of the stop-valve of the steam-engine, if its sudden stoppage should become necessary. It has been applied by Mr. Tate to the driving-engines of his large woollen-mills in Bradford. The mechanism consists of a weighted suspension rod attached to the stop-valve by a bracket, and actuated by a small steam-cylinder, the piston of which is supplied with steam through a valve which is opened by the action of the electro-magnet and the weighted rod. The movement of this auxiliary engine shuts the stop-valve of the engine in a small fraction of the time usually required to close it by hand. The wires of the battery are carried to various parts of the mill, so that the engine can be 'shut down' at any instant, and from any one of a number of promptly accessible points. This arrangement is proposed to be attached to the engines of steam-vessels, the wires being led to the bridge, and to other parts of the vessel where the officers can easily reach the button. — (*London times*, Oct. 21.) R. H. T. [46

Forms of steamers. — Two vessels recently built by the Messrs. J. & G. Thompson have been compared to determine their relative economy as a means of transportation as affected by a considerable difference in proportions. One was 390 feet long, 42 feet beam, and drew 18 feet of water : the second was 375 by 45 by 20 feet. The longer vessel had less fine ends than the broader ship. The former required 5,100-horse power to drive her 15 knots an hour, while the latter only demanded 3,900. At 13 knots, the power demanded was the same for both ; but at higher speeds the difference became greater and greater, and more and more in favor of the shorter, broader, but finer ended vessel. The gain to be expected from giving ships greater beam, and, at the same time, finer ends, is expected to be observed in larger and faster vessels. — (*Mechanics*, May 26.) R. H. T. [47

Efficiency of the steam-engine. — Professor R. R. Werner, of the Technical high school at Darmstadt, publishes a paper describing his trial of a compound engine driving a mill in Augsburg. The engine has an indicated power of 132 horses. The cylinders have a proportion of 2.75 to 1 ; they are steam-jacketed, as is the intermediate reservoir ; the ratio of expansion is 14. The boilers carry a pressure of about 7 atmospheres, and the steam supplied contains 3 per cent water. The steam-jackets condense about 11 per cent of the steam, and the cylinders demand about 7 kilograms (15.4 lbs.) of steam per horse-power and per hour, beside that condensed in the jackets. This is about the amount required as a minimum in the best-known English and American engines. In this country, a very similar figure has been reached by Corliss and by Leavitt. — (*Zeitschr. ver. deutsch. ing.*, May.) R. H. T. [48

'Compound' locomotives. — M. Mallet communicates to the French society of engineers a note from M. Borodine, giving the results of experiments to determine the relative economy of the simple and the compound system of engine for locomotives. The engines experimented with were those designed for the railway from Bayonne to Biarritz by M. Mallet. The trials extended over a considerable period of time, and the comparisons were made fairly complete. The result showed the compound system to have an economy of from ten to twenty per cent, according to the conditions under which they are carried out. The variation in the ratio of expansion is very greatly restricted in the compound engine. The use of the steam-jackets with which the engines were provided did not prove to be of advantage. The expenditure of steam was greater when they were in use than when they were shut off. — (*Mem. soc. ing. civ.*) R. H. T. [49

CHEMISTRY.

(Organic.)

Compounds of benzotrichloride with phenols and phenylamines. — When a mixture of one molecule of benzotrichloride and two molecules of phenol is heated gently, O. Döbner finds that the following reaction takes place: —

$$C_6H_5CCl_3 + 2\,C_6H_5OH = C_6H_5CCl\begin{matrix} C_6H_4OH \\ C_6H_4OH \end{matrix} + 2\,HCl.$$

The remaining chlorine atom is replaced by a hydroxyl group when the product is heated with water, forming dioxytriphenylcarbinol, —

$$\begin{matrix} (OH) \diagdown & & \diagup C_6H_5OH \\ & C & \\ C_6H_5 \diagup & & \diagdown C_6H_5OH \end{matrix}.$$

By reduction, dioxytriphenylmethan

$$\left(\begin{array}{ccc} H & & C_6H_5OH \\ & C & \\ C_6H_5 & & C_6H_5OH \end{array}\right)$$

is formed. An analogous reaction takes place if resorcine is used instead of phenol. The resulting resorcine benzein, by reduction, gives tetraoxytriphenylmethan, —

$$C_9H_5CH \quad CH^{C_6H_3(OH)_2}_{C_6H_3(OH)_2}.$$

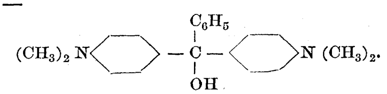
With primary aromatic amines, benzotrichloride united readily. When added to a mixture of dimethylaniline and zinc chloride, it formed malachite green, —

$$\begin{array}{ccc} (OH) & & C_6H_4N(CH_3)_2 \\ & C & \\ C_6H_5 & & C_6H_4N(CH_3)_2 \end{array}.$$

By reduction, this substance gave the corresponding leuko-base, —

$$\begin{array}{ccc} H & & C_6H_4N(CH_3)_2 \\ & C & \\ C_6H_5 & & C_6H_4N(CH_3)_2 \end{array}.$$

The base malachite green was easily decomposed, when heated with hydrochloric acid, into dimethylamine and benzoyldimethylaniline. This reaction points to the following structure for malachite green: —



The action of benzoyl trichloride upon hydroxyl or amido compounds seems, therefore, to be normal to the para position with respect to the amido or the hydroxyl group. — (*Ann. chem.*, ccxvii. 223.) C. F. M. [50

GEOLOGY.

Lithology.

The Potsdam and St. Peters sandstones. — The surface induration of the friable Potsdam and St. Peters sandstones, as determined by macroscopic observations in 1871-73, was brought to the notice of the readers of SCIENCE some time ago (i. 146), while a recent interesting paper by Prof. R. D. Irving gives the results of his microscopic investigations on the same subject. Irving finds, as Sorby had previously, that ordinary quartz grains, formerly rounded and worn, have been built out and supplied with crystal facets from silica deposited later on them. He finds that the induration of the above-mentioned sandstones arises from the deposition of intersticial quartz cementing the grains. The deposited quartz is found to be optically oriented, the same as the enclosed grain, which is distinguished by its cloudiness and worn surface, and frequently by a coating of oxide of iron upon it.

To the deposition of quartz upon worn quartz grains is ascribed the occurrence of quartz crystals in the Potsdam sandstone described in 1882 by Rev. A. A. Young. Credit should have been given by both Irving and Young to Rev. John Murrish for calling attention to the occurrence of quartz crystals in Potsdam sandstone in 1870-72 (*Bull. Wisc. acad.*, ii. 32), especially since Murrish's observations were discredited at the time.

All quartz crystals in sandstone have not this derivation, as the writer showed for the Lake Superior sandstone in 1880, the crystals of which come from old eruptive rocks owing to the decomposition of the matrix. It is pleasant to find my earlier observations on the surface induration of the Wisconsin sandstones, and the formation in them of quartz crystals, sustained by the much more complete and valuable work of Irving, made, as his was, without any knowledge of mine.

Irving holds that the quartz deposited may come from the action of water on the occasional felspar particles in the rock, although sometimes from an external source. He further regards the induration of quartzites and quartz schists as caused by the same deposition of intersticial quartz. — (*Amer. journ. sc.*, xxv. 401.) M. E. W. [51

Antase as an alteration product of titanite. — The titanite in a biotite amphibole granite from the Troad was found by Mr. J. S. Diller to be replaced by a light wine-yellow to honey-yellow mineral, showing, under the microscope, quadratic and rhombic sections. The former are isotropic, and have a well-marked cleavage parallel to their sides; the latter are strongly doubly refracting, extinguish parallel to the diagonal, and have one cleavage parallel to the short diagonal and another to the edges. In order to isolate the substance, the finely pulverized rock was separated into two portions, one of lighter and the other of heavier specific gravity than 2.72, by means of the potassium-iodine-mercury solution. The yellow mineral was found in the second portion, which contained also iron ore, zircon, and apatite. The ore was removed by the electro-magnet, and the apatite by nitric acid. By means of the cadmium-boron-tungstate solution it was shown that the yellow mineral had a specific gravity between 3.6 and 4.5. Some grains were picked out, and found to be insoluble in hot aqua regia.

The mixed zircon and yellow mineral powder gave a reaction for titanium, while the pure zircon would not: hence it was inferred that the mineral contained titanium. Its angles were found to be 98° 24′ and 136° 16′, while the corresponding ones of antase are 97° 51′ and 136° 36′. From its optical, chemical, and crystallographic characters, it was then inferred that the yellow mineral was antase. — (*Neues jahrb. miner.*, 1883.) M. E. W. [52

GEOGRAPHY.

(*South America.*)

The Puno railroad, Peru. — Dr. R. Copeland gives a readable account of a journey over this remarkable railroad from its beginning at Mollendo on the coast, through Arequipa, to Puno on Lake Titicaca, and of his farther travels by boat on the lake, and by stage, beyond to La Paz in Bolivia. The features that attracted his special attention were the deep, narrow valleys followed by the road in its sharp windings while ascending from one pampa level to the next; the broad, flat, barren pampas at great and greater altitudes; and the superb views of the volcanic peaks and ranges of the Cordillera, — Misti,

Chaycam, and Pichupichu, eighteen to nineteen thousand feet in height. On the pampa of La Joya (4,100 feet) he saw countless hillocks of pure, sharp sand (*médanos*), in half-moon form, with the curve to the west or windward (see SCIENCE, i. 488). A mirage gave these white hills the appearance of drift-ice in an arctic sea. — (*Deutsch. geogr. blätter*, vi. 1883, 105.) W. M. D. [53

Colombia. — R. B. White, for several years resident in Colombia, and a companion of Stübel and Reiss in some of their expeditions, furnishes a summary account of the more attractive parts of this republic, and of its productions, and chance of development. Several of the rivers that flow northward between parallel ranges of the Cordillera are navigable for small steamers for many miles into the interior, opening districts well adapted to agriculture, and well supplied with timber and mineral products. Above the low plains the climate is healthy. A good share of the world's platinum supply is obtained from the upper valley of the San Juan, and gold occurs in profitable quantity in many of the river-gravels. Brief mention is made of an ascent of the snowy volcano, Puracé; and the extensive view from the Cerro Munchique, nearly ten thousand feet high, west of Popayan, is highly praised. The geological observations on the origin of mountain and valley form do not carry conviction, and the frequent mention of volcanic upheaval and valleys of fracture remind one of the theories of fifty years ago. — (*Proc. roy. geogr. soc.*, v. 1883, 249.) W. M. D. [54

(*Africa.*)

The Kongo. — Dr. Pechuel-Loesche, a member of the German-African expedition to Loango in 1873-76, and later in charge at Stanley Pool while Stanley went to Europe, recently read an address on the Kongo and the neighboring mountains of western Africa before the German geographical congress at Frankfort. The river is remarkable for the rapids all along its course, and especially in its narrow passage through the mountains below Stanley Pool, where it falls nine hundred and twenty-eight feet in some three hundred and forty miles. Of the several falls in this part of its course, only one is vertical, that of Isangila, with a height of sixteen feet. There are two periods of high water, with a rise of twenty feet, when the falls disappear in a uniform rushing flow. The water rises from September to January, falls from January to March, attains its greatest height in the rainy months (April and May), and its lowest level in July and August. Many of the mountain brooks have cut deep channels, and join the main stream on a level; but some of the larger rivers of the interior, flowing over horizontal rocks, have not cut their way so deeply, and, on joining the Kongo, form cataracts. Thus the Luenga falls three hundred feet, and the Luvubi five hundred feet. (This, if correctly reported, is certainly a very abnormal arrangement.) The mountain belt is about two hundred miles wide, rising from a sloping plain at about one thousand feet to rounded and monotonous elevations with a maximum of three thousand feet. The higher land is grassy, with small trees and apparently leafless bushes: the more luxuriant growth of lofty trees and palms is hidden in the valleys. It is these deep and steep-sided valleys that make the rather open upland difficult to traverse. Near the river, the natives have destroyed all the forest-trees, either by burning or cutting. The villages are built on high and bare summits. Dr. Pechuel-Loesche regarded the Makoko (ruler of the stream), with whom de Brazza had made a treaty two years ago (SCIENCE, i. 79), as a local ruler of no general authority. The Makoko's son had reported that his father had ceded no land to de Brazza, and that he had no French flag in his possession. There are four Makokos in this region; and none of them has a right of precedence over the others, or any title to be sovereign of the Bateke population of this part of the Kongo. — (*Proc. roy. geogr. soc.*, v. 1883, 286.) W. M. D. [55

The muatiamvo of the southern Kongo basin. — Max Buchner, the fourth European who has been in this region in the last two centuries, spent half a year at the residence of the 'muatiamvo,' or king (SCIENCE, i. 19), and reports on the peculiar form of his government. The kingdom on the southern side of the Kongo basin, the special field of the German-African explorations, includes an area about as large as Germany. Its population can hardly exceed two millions, and its power cannot compare with that of Mtesa's country, farther east, where an army of a hundred thousand men can take the field. Here the army is not more than one thousand strong at the highest; and Buchner says he could go where he chose with fifty European soldiers, if they were not attacked by that more dreaded enemy, the African fever. And yet, through a large part of south-western Africa, the muatiamvo is the greatest native power. The most notable peculiarity of the government consists in the presence of a second high authority besides the muatiamvo, namely, the 'lukokessa,' or queen: she is not the wife of the king, who has some sixty wives of his own, but is free and independent of him, having her own chief consort, the 'shamoana,' and numerous frequently changing husbands of lower order. Buchner traces the origin of this form of government, and gives a list of thirteen muatiamvos, down to Shanana or Naoesh-a-kat, the present king, and describes the different parts of the kingdom and its neighboring states. — (*Deutsche geogr. blätter.*, vi. 1883, 56.) W. M. D. [56

BOTANY.

Pollination of Rutaceae. — Urban has studied the adaptations for fertilization in a considerable number of species of this heterogeneous order, using living material at the Berlin botanic garden. As few of the genera have been previously studied in this respect, a rather full translation of his tabulated summary is given.

I. MONOCLINOUS SPECIES.

A. *With dichogamous (protandrous) flowers.*

1. Nutation successively places the dehiscent anthers at the point which the receptive stigma occupies later.

a. Style undeveloped in the staminate stage.

α. The filaments rise from their original horizontal position, place themselves against the ovary, resume their original position, and again become erect, but without lengthening; petals plane; self-pollination usually impossible: *Ruta.*

β. The originally short, erect filaments lengthen, curve inwards, and again straighten; petals united below in a tube; close pollination possible by gravitation: *Coleonema.*

b. Style developed in the staminate stage, though not always to its full length; so placed as to oppose self-pollination.

∸ Flowers zygomorphic.

α. The stamens which lie on the lower lip successively bend upward, and, after dehiscence, resume their original position; the end of the style likewise bends up at maturity: *Dictamnus.*

β. The stamens, originally bent upwards, successively straighten at maturity, then bend outward; the style, bent downward when young, straightens when the stigma becomes receptive: *Calodendron.*

≐ Flowers actinomorphic. The filaments successively elongate after dehiscence.

α. In the staminate stage the style is bent horizontally across the ovary; the stamens bend over the pistil successively at maturity, then lengthen, and turn outward between the finally erect petals: *Diosma tenuifolia.*

β. Similar to the last; but the staminodia, and not the petals, become erect, the stamens bending outward but little: *Adenandra.*

γ. After flowering, the style bends outward and downward between the staminodia, the petals remain horizontal, the staminodia lie against the ovary, and, after dehiscence, the fertile stamens resume their original horizontal position: *Barosma.*

2. The stamens nutate but once, and simultaneously. In the staminate stage they are perpendicular, or incline but little toward each other, so that the anthers are in contact at their margin; in the pistillate stage they have bent outward.

a. The anthers fall away when the filaments curve outward: *Ravenia.*

b. Anthers persistent on the bent filaments.

∸ Pollen may fall on the unreceptive stigma, and so effect self-fertilization. Even later this is not impossible, as the wind or gravitation may carry pollen from the reflexed stamens to the mature stigma.

α. In the pistillate stage the style elongates: *Zieria* and *Eriostemon.*

β. With normally developed stigma: *Boronia* (ex parte).

γ. When the style lengthens, the stigma may encounter the anthers of the still erect stamens: *Erythrochiton.*

≐ The viscidity of the pollen, and the situation of the anthers, prevent self-pollination: *Metrodorea.*

3. The stamens do not nutate at all.

a. Self-pollination possible in the pendant flowers after the separation of the lobes of the stigma: *Correa.*

b. The style is surrounded by staminodia in the first stage; in the second stage spontaneous pollination by neighboring flowers may occur if insect-crossing has not been effected: *Agathosma* (ex parte).

B. *With synacmic flowers.*

1. Self-fertilization impossible.

a. With viscid pollen: *Boronia* (ex parte).

b. The stigma surpassing the anthers: *Triphasia.*

2. Spontaneous self-pollination impossible because of the situation of the filaments, but spontaneous crossing between neighboring flowers favored: *Agathosma* (ex parte).

3. Spontaneous pollination of either sort opposed; crossing by insects inevitable: *Crowea.*

4. Spontaneous close fertilization possible; crossing favored: *Cusparia, Choisya, Skimmia* (ex parte), *Murraya, Citrus.*

II. DICLINOUS SPECIES.

Self-fertilization impossible; crossing necessary: *Ptelea, Skimmia* (ex parte). — (*Jahrbuch bot. gart. Berlin,* ii.) W. T. [57

ZOÖLOGY.

Mollusks.

Credit to an American naturalist. — In an official report by M. Bouchen-Brandely, secretary of the college of France, the author states that he has learned by two years of study that the sexes of the Portuguese oyster are confined to separate individuals; that after this discovery he conceived that it might be possible to artificially fertilize the eggs of this mollusk; and that, after two years more of experimenting, this attempt has been successful. Americans will be interested to learn that in 1879 an American naval officer, Lieut. Francis Winslow, who was stationed at Gibraltar for a few weeks, determined the unisexuality of the Portuguese oyster, and reared it from artificially fertilized eggs. His results were printed in the *American naturalist* in 1879 or 1880; but, as I have no opportunity for reference at present, I cannot give the exact date. — W. K. B. [58

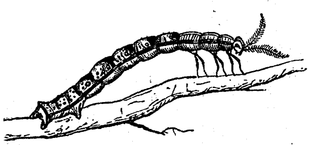
Notes. — In the year-book of the Verein für vaterländische naturkunde in Württemberg, published lately at Stuttgart, Weinland has a paper on the mollusk fauna of the Württembergisch Franken, and Wundt one on the zone of Ammonites transversarius in the Suabian white Jura. —— The second part of the *Quarterly journal of microscopical science* contains a paper by Lankester on the existence of Spengel's olfactory organ and of paired genital ducts in Nautilus pompilius. —— Heude's 'Conchyliologie fluviatile' of Nanking and Central China approaches completion. The ninth and concluding fasciculus will appear during the present year. It is luxuriously illustrated, and printed in large quarto. —— Kuster's continuation of Martini and Chemnitz Conchylien cabinet bids fair to go on, like Tennyson's brook, forever. Lieferung 322 is announced. This work would be much benefited by the total exclusion of the frightful engravings which illustrated the earlier editions and are still pressed into the service. —— J. B. Gassiés, known by his concho-

logical researches in New Caledonia and Southern France, has recently died. — W. H. D. [59

Insects.

American paleozoic insects. — R. D. Lacoe, whose collection of these objects must be one of the largest, if not the largest, in the country, has prepared a list of those hitherto published, including twenty-six genera and forty-eight species of hexapods, five genera and species of arachnids, and nine genera and nineteen species of myriapods, — a total of forty genera and seventy-two species. This embraces, however, three genera and fourteen species still unpublished. The list is purely bibliographical, excepting that it contains careful statements of the place of discovery of the fossils, the name of the finder, and the place of present deposit. About half of the described species have been published within the last five years. — (*Wyom. hist. geol. soc., publ.* 5.) [60

A monstrous caterpillar. — E. H. Jones figures a curious larva of the geometrid moth Melanippe montanata of Europe, which he exhibited at an entomological reunion at the Royal aquarium on March 5. It has the antennae and legs of the perfect insect fully developed, while in other respects a normal larva. It was reared from the egg with a dozen others. Last November this one, then normal, was considerably larger than the rest of the brood,



Abnormal larva of *Melanippe montanata*.

and was noticed as a constant feeder. "On Feb. 15 I was astonished to find that this forward individual had developed the antennae of the imago, but without in any other way altering its larval appearance. For a space of two or three days the antennae were beautifully pectinated, and then the prolegs [thoracic legs ?] of the imago became perfect. . . . Both antennae and legs then gradually shrank and dried until the 20th." — (*Entom.*, xvi. 121.) [61

VERTEBRATES.

Temperature and pulse rate. — By means of his new method of isolating the mammalian heart, Prof. Martin has been able to make an accurate study of the effect of variations of temperature on the rate of beat of the dog's heart when completely separated physiologically from all the rest of the body except the lungs. In the brief abstract of his work which has been published, a short description of the method of operating is given, together with some of the more important results which have been obtained. He finds that in the mammalian heart, as in that of the frog, the rate of beat is gradually increased as the temperature of the blood is raised from 27° to 42° C. The quick pulse of fever can therefore be explained by the direct action of the heated blood on the heart itself, without assuming any special action upon the extrinsic inhibitory or accelerator nerve-centres.

The rate of beat of the heart is found to bear a much more direct relation to the temperature of the blood in the coronary arteries than to the temperature of the blood in the right auricle or ventricle.

An interesting point which comes out of the method of work is, that, although the defibrinated calf's blood used to nourish the heart was repeatedly circulated through the heart and lungs for several hours, it gave no evidence of clotting at the end of an experiment, showing that fibrinogen is not formed in these organs. — (*Proc. roy. soc.*, no. 223, 1883.) W. H. H. [62

Lymphatics of periosteum. — George Hoggan and Frances Hoggan criticise the previous writings on this subject, and give the results of their own studies. They assert that what Budge described as the lymphatics are really capillary blood-vessels. Their own conclusions they summarize as follows : —

1. The lymphatics of the periosteum exist only on the outer surface, or within the outer gelatinous (white fibrous) stratum of the membrane. They never ramify upon the inner or bony surface. 2. When the periosteum is thin, more especially when the animal is old, the whole lymphatic plexus lies free upon the outer surface; but when the periosteum is thick, lymphatic twigs may pass part way through, but they never reach the inner surface. 3. The lymphatics accompany the blood-vessels, as if arranged to drain them. 4. No lymphatics exist on the surface of the great cavities of the bone. "There is thus every reason to believe that the lymphatics never come in contact with the bone itself, and that bone possesses no lymphatics apart from those found within the periosteum, which may be physiologically considered, therefore, as the lymphatics of bone." — (*Journ. anat. physiol.*, xvii. 308.) C. S. M. [63

Fish.

Classification of the Petromyzontids. — The Lampreys have been systematically considered by Gill, and are differentiated into two sub-families: 1. The Petromyzontinae, 'with the suproral lamina median and undivided;' and 2. The Caragolinae, 'with two lateral suproral laminae.' The former embraces six genera, one of which is named for the first time Exomegas, and is intended for the Petromyzon macrostomus of Buenos Aires: the Caragolinae are confined to the southern hemisphere; i.e., Australia and Pacific South America. — (*Proc. U. S. nat. mus.*, iv. 521.) [64

Characters of the Ephippiids. — The family of Ephippiids is distinguished by T. Gill from the Chaetodontids by the bifurcation of the post-temporal bones, and the wide, scaly isthmus extending from the pectoral region to the chin, and separating the branchial apertures.—(*Proc. U. S. nat. mus.*, iv. 557.) [65

Extinct fauna of Idaho and Oregon. — Professor E. D. Cope, referring to the remains of

fishes from the middle valley of the Snake River in Idaho and eastern Oregon, stated that bones collected from sections now dry, but which had formerly been portions of lake-basins in the Oregon district, indicated a close relationship with the fishes now found in the remaining lakes and rivers. The number of species of fishes collected from the Idaho beds amounts to twenty-two. They are all distinct from those found in the Oregon basin, and cannot be identified with existing forms, although, with two exceptions, they belong to existing genera. Four of the families of fishes obtained from these beds are not now found west of the Rocky Mountains, except a single species of one of them (Percidae) in California. Of even greater interest was the fact that this fauna includes representatives of the Cobitidae, — a family of fishes entirely absent in the living fauna of North America. The presence of their remains in the Idaho beds indicates a probable former connection between North America and Asia. The names 'Idaho Lake' and 'Idaho deposits' were proposed for the lake and deposits now first described. The formation is distinct from any previously known, and is older than the Oregon lake-deposit. With the exception of fishes, the remains of but few vertebrates were found in the Idaho beds, although the Oregon deposits are full of the bones of mammals and birds. The means of indicating the exact geological position of these pliocene beds, as compared with those of Europe, was as yet wanting. — (*Acad. nat. sc. Philad.; meeting* June 19.) [66

Reptiles and batrachians.

Spermatozoon of newt. — Dowdeswell describes a very minute barb at the tip of the head of the spermatozoon of the newt: it measures 1.5μ in breadth by 2μ in length. He looked for it in other animals, but did not find it. — (*Quart. journ. micr. sc.*, 1883, 336.) C. S. M. [67

Nerves of the frog's palate. — Stirling and Macdonald describe fully the palatine nerves of the frog, their origin, and their general and minute distribution. There is a coarse plexus of medullated fibres and a finer plexus of naked fibres, which last innervate the blood-vessels and the glands, besides forming the ultimate ramifications of the nerves. In the course of the former plexus are scattered unipolar cells, each with a straight and a spiral fibre. There are, besides, many details given. This well illustrated and admirably written paper may be specially commended to histologists engaged in laboratory practice. — (*Journ. anat. physiol.*, xvii. 293.) C. S. M. [68

ANTHROPOLOGY.

Australian class systems. — In the Australian division of the tribe the communes are represented by two primary classes, each of which has a group of totem names, which are chiefly names of things animate or inanimate. The two primary intermarrying classes are over a large part of south-eastern Australia called Eaglehawk and Crow. Each group of totem names is a representation of its primary; and, as a general rule, any one of the group may marry with any other of the complementary group. If the primaries are A and B, and the groups, 1, 2, 3, etc., and i, ii, iii, etc., in certain localities, A 1 must marry B i only, and so on. The next change is the subdivision of A and B as in the Kamilaroi, thus: —

$$\left.\mathrm{A}\begin{cases} a \\ \alpha \end{cases}\right\} 1, 2, 3, \text{etc.}$$

$$\left.\mathrm{B}\begin{cases} b \\ \beta \end{cases}\right\} \text{i, ii, iii, etc.}$$

The effect of this is to remove the woman of the second generation from the possibility of marrying her father. Were this not so, the law 'A (male) marries B (female)' would permit A to take his daughter to wife, the simpler law forbidding the marriage of brothers and sisters only.

Under the form $a + \alpha = \mathrm{A}$ and $b + \beta = \mathrm{B}$, each half of an original class has marital rights over the women of one particular half of the other class, whose children do not take the class name of the mother, but of the sister class. For example: $a + \beta = b$, who must marry α; and the children of the third generation, by mother right, will be again a and β. Mr. Howitt, who has worked out these systems with great patience, is of the opinion that this subdivision into classes was designed to render impossible those unions which were considered, and are now considered, as deep pollution. He has certainly given the most rational explanation of aversion to mothers-in-law. Under the old *régime* a daughter was of the clan of her mother, and B could marry any A. The law against looking at a mother-in-law, therefore, was to prevent the possibility of marrying her.

Mr. Howitt sums up his labors in the following conclusions: 1. The primary division prevented brother and sister marriage; 2. The secondary, intermarriage between parents and children; 3. The prohibition of intercourse between a woman and her son-in-law prevented connections not to be reached by class rules; 4. These changes were all reformatory in the community. — (*Journ. anthrop. inst.*, xii. 496.) J. W. P. [69

Region of man's evolution. — Mr. W. S. Duncan is the author of a paper upon the probable region of man's evolution, in which the following points are made. Man formed one of a set of families of man-like animals, somewhat similar to the present apes. Since only the lowest members of the Primates have been distributed to the eastern and the western continent, it is probable that the Primates originated within the arctic circle, while the higher groups sprang from the eastern continent: man, therefore, did not originate within the arctic circle, nor in the new world. The Cynopithecidae, since tertiary time, have been spread over nearly the entire eastern continent. The Semnopithecidae have been dispersed over central and western Europe to southern Europe and south-eastern Asia, as far south as Ethiopia. The anthropoid apes have been more circumscribed, but all the genera of living apes are derived from southern Europe and subtropical Asia. As apes existed

in Europe and Asia before they reached the tropics, so we may infer that man existed in Europe and Africa before the low types, the Akkas and the Aetas, occupied tropical Asia and Malasia. The present habitat of the apes is not conducive to change: we must look to some region where apes were compelled to change their food and modes of locomotion. The stoppage of the southern migration by vast sheets of water shut up the apes in temperate regions. The crowding of other animals in the same locations sharpened the intelligence of the precursor of man. Here, then, Mr. Duncan supposes the great conflict and transition from man-like apes to ape-like men took place. — (*Journ. anthrop. inst.*, xii. 513-525.) J. W. P. [70

Tylor's lectures at Oxford. — The concluding portion of Dr. Tylor's lectures on anthropology, delivered in the Oxford museum in February (see i. **1055**), is devoted to the history of the growth of practical art. "In considering the claims of anthropology as a practical means of understanding ourselves, we have to form an opinion how the ideas and arts of any people are to be accounted for as developed from preceding stages. To work out the lines along which the process of organization has actually moved, is a task needing caution. A tribe may have some art which plainly shows progress from a ruder state of things: and yet it may be wrong to suppose this development to have taken place among themselves; it may be an item of higher culture, that they have learned from sight of a more advanced nation. It is essential, in studying even savage and barbaric culture, to allow for borrowing." Illustrations are given by Dr. Tylor of this borrowing, one of which is quite amusing. The later Danish travellers among the Eskimo enter very minutely into the description of the tools and dress of these people, before contact with Europeans, meaning the post-Columbian voyagers; but, unwittingly in many instances, they are describing fashions and forms borrowed from the Skraelling ancestors of these very writers a thousand years ago. Another very important point discussed in the lectures is the possibility of national degradation. Dr. Tylor was the first to discover, after the battle between the advocates of 'degradation' and those of evolution, that both were right, and that a proper view of human history must include both vicissitudes over and over again, and the commingling of both in every degree of complexity. Mr. Tylor gives a succinct account of the formation of the Pitt-Rivers collection, now housed at Oxford, and, in commenting upon the evolution of gesture-speech, pays this tribute to our country: "The labor and expense which anthropologists in the United States are now bestowing on the study of the indigenous tribes contrasts, I am sorry to say, with the indifference shown to such observations in Canada, where the habits of yet more interesting native tribes are allowed to die out without even a record." With very great shrewdness the speaker discussed the subject of magic and the benefit derived from even such useless search as that for the 'lost tribes of Israel.' — (*Nature*, May 17.) J. W. P. [71

The North-American Indians and the horse. — Professor Hovelacque, in his recent work Les races humaines, gives as one of the important characterizations of the North-American Indians the statement that they do not breed horses, leaving it to be inferred from the context that they obtain their supply from wild herds. It may be remarked, that, however general the use of horses is at this time among the Indian tribes of the great plains, an ethnologic distinction based upon any treatment of that animal — a European importation and intrusion — is hardly legitimate. For centuries after the Columbian discovery but a small proportion of the tribes of North America ever saw a horse. The fact that the horse was not known to or used by them in their prehistoric condition constitutes an important element in establishing their position in the ethnic scale, their rise from savagery and barbarism having been retarded by that deprivation. Further, it must be suggested that there is little evidence, apart from the novels of Capt. Mayne Reid and similar authorities, of the existence in North America of herds of wild horses similar to those in South America, sufficiently large to supply the Plains tribes. There were, doubtless, some wild horses, the descendants of those imported by the Spaniards, in a condition to be captured by a past generation; but probably no living Indian has relied upon recruiting his stock from such herds, and his horses have been obtained by the civilized method of purchase or the more convenient process of stealing. The latter expedient has of late years been stopped by the powers of the United States authorities: so some of the tribes have learned to breed from their horses, though as yet the practice is limited by the same want of prudence as is shown in their neglect to provide food and shelter for their ponies. The whole connection of the tribes with the horse simply shows a course of education to a certain extent by a foreign civilization. The statement of M. Hovelacque is therefore as untrue in fact as it is unphilosophic as an ethnic characterization. — J. W. P. [72

EARLY INSTITUTIONS.

Land-holding in South Africa. — Sir H. Bartle Frere gives us an account of the systems of land-tenure among the aboriginal tribes of South Africa, — Bushmen, Hottentots, Kaffirs. Among the Kaffirs, if a man wishes to leave the paternal kraal, he seeks a tract of unoccupied land, and builds a kraal for himself. His wives proceed to cultivate as much land as they please, and the live-stock is turned out to pasture. The settlement descends from father to sons, unless, as often happens, this is prevented by the chief or an enemy. Titles rest simply on force. A man owns the land he occupies as long as he can hold it by his own might, or with the aid of the chief, or the tribe, if this is given. Authority of the chief or elders to resume or recognize possession has not been discovered by Sir Bartle Frere; but he says that it may, perhaps, be discovered by future investigators. — (*Journ. anthrop. inst.*, Feb.) D. W. R. [73

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Naval bureau of ordnance.

Experiments at Annapolis. — By direction of the Naval bureau of ordnance, experiments with the six-inch steel gun were resumed at the experimental battery recently, the chief object being to develop and encourage the home manufacture of steel projectiles. Steel projectiles manufactured by the Midvale steel company near Philadelphia, having different physical characteristics as to toughness, extensibility, etc., were fired at a target consisting of two mild steel five-inch plates strongly bolted together, and backed with twenty inches of live-oak. The first and the second shots broke up; the third pierced the plates, and was stopped by the backing; while the fourth perforated target and backing, and buried itself in a mound of earth beyond the target. This projectile had an initial velocity of 1,983 feet, and weighed 75 pounds. The charge of powder was 32 pounds, and the striking energy per inch of shot's circumference was 108 foot-tons. The results indicate that there will be no serious difficulty in procuring the proper material for armor-piercing shells in this country.

A somewhat remarkable result was obtained with a projectile weighing 52 pounds, and a charge of 33 pounds of powder. The muzzle velocity obtained was 2,323 feet per second, with a pressure of about 13 tons. The ratio of charge to projectile was adopted as being nearly that which will be used in the new ten-inch guns designed by Commodore Sicard. These guns will be manufactured at the Washington navy-yard, and are intended for the batteries of the four double-turreted monitors.

It does not necessarily follow that results equally favorable will be obtained with the ten-inch gun, since the masses of both charge and projectile will be greatly increased. The pressures will doubtless be higher; but these guns will be sufficiently strong to withstand a working pressure of more than 25 tons to the square inch. The indications, however, are, on the whole, extremely favorable to the success of the ten-inch gun.

This experiment is likewise interesting when compared with the record of a six-inch gun constructed by Sir William Armstrong, in which, with an 80-pound projectile and a charge of 55 pounds of powder, a muzzle velocity of 2,297 feet was reached with a pressure of 21 tons. In the latter case the ratio of charge to projectile is 11:16, whereas in the former case the ratio is 11:17⅓. It is to be regretted that the size of the chamber of this experimental gun does not permit the employment of a larger charge of powder.

Two six-inch guns, representing the types proposed for the broadside batteries of the new steel cruisers, are now in process of construction at the Washington navy-yard, and will be ready for testing in August. — J. M. R.

U. S. magnetic observatory at Los Angeles, Cal.[1]

Magnetic observations. — There is at present but one self-registering magnetic observatory within the limits of the United States. That observatory is located in Los Angeles, Cal.; and the object of the present article is to present a brief description of the observatory and its work, together with a short account of its origin.

Continuous series of magnetic observations, covering longer or shorter periods, have been made at several stations in North America; but, with two exceptions, they have all been made on the eastern side of the continent. We have a series of observations of five years (1840–45) at Girard college, Philadelphia, by A. D. Bache; six years' observations at Key West, Fla. (1860–66), by the U. S. coast-survey; and a long series, still continuing, at Toronto, Canada (1841–83). We have, further, a series of nearly five years of photographic records taken at Madison, Wis., by the U. S. coast and geodetic survey.

On the western coast the only continuous series of magnetic observations we have, were made by the Russian government at Sitka at the magnetic and meteorological observatory established in March, 1842, and maintained until the cession of Alaska to the United States in October, 1867; and the series of hourly observations at Point Barrow in 1852–54 by Capt. Maguire, R.N. Up to the present time, a great part of these observations have remained undigested and undiscussed.

It was therefore contemplated by the coast-survey, many years ago, to obtain a continuous series of magnetic records from some station on the western coast of the United States; and, with this end in view, an Adie magnetograph of the latest and most approved pattern was purchased in 1860. The outbreak of the war, however, prevented the carrying-out of this plan.

The instruments remained packed until 1878, when a favorable time seemed to have arrived to put it to use. Assistant C. A. Schott, aided by Mr. Suess, then set it up for trial in the basement of the coast-survey office in Washington. Some minor defects of construction were remedied, and the magnetograph set to work in January, 1879. It was kept going for about two weeks on trial, and found to perform satisfactorily. During this time, it was inspected by Superintendent Patterson, and its workings observed by various members of the survey. At the close of this trial it was packed up for shipment to some station in California.

It was found, however, that more money would be required to run the instrument than could be then set apart for this work, and it therefore remained in the coast-survey office.

In response to the invitation of the International polar conference, our government consented, in 1881,

[1] Communicated, with permission of the superintendent of the U. S. coast and geodetic survey, by MARCUS BAKER, acting assistant in charge of the observatory.

to the establishment of two observing stations in high northern latitudes. Observations, especially of meteorology and magnetism, were to be undertaken; and it was arranged to carry on these observations under the joint auspices of the signal-service and coast and geodetic survey. The executive management of these stations, the selection of observers, etc., were put under the direction of the chief signal-officer. The coast-survey co-operated by furnishing such magnetic instruments as were on hand, and by training, during the short time available for their work, the magnetic observers selected by the signal-office. It is to be regretted that there was not time enough to procure suitable differential instruments for the stations.

Two parties were despatched to the north, — one to Lady Franklin Bay, near the northern end of Greenland, under the charge of Lieut. A. W. Greely; and the other to Point Barrow, Alaska, under the direction of Lieut. P. H. Ray. Both these parties reached their destination in the fall of 1881.

It was the wish of the International polar conference that all the northern stations should be occupied three years; and a special effort was to be made to secure a complete and continuous record from August, 1882, to August, 1883. In the spring of 1882, additional observers were selected by the signal-office to replace any of the former ones that might have become disabled, or to act as auxiliaries, should such be needed. These magnetic observers, like their predecessors, received instruction at the coast-survey office prior to their departure for the north; and a set of differential magnetic instruments, hastily constructed, was sent to Point Barrow.

The spring of 1882 seemed, therefore, a peculiarly favorable time to put the Adie magnetograph to work, and to secure at one and the same time the long-desired series of magnetic observations from the western coast, and a series which would also be available for comparison with those observations made at the International polar conference stations. It was therefore mutually agreed by the signal and coast survey offices to establish a magnetic station at the joint expense of the two offices. In the case of the northern stations, the management was intrusted to the signal-office. The expense of the Lady Franklin Bay station was specifically provided for by act of Congress. The expense of the Point Barrow station was to be borne by the signal-service and coast and geodetic survey jointly. In the new station to be established in California, and which was to be devoted to observations of magnetism only, the management was left entirely to the coast-survey.

At first San Diego was suggested as the site of the new station, it being the place on the western coast of the United States farthest from the northern stations. A somewhat better location, nearly as far south, was, however, finally selected in Los Angeles, Cal.

Plans for a building were prepared in Washington, and forwarded to Assistant J. S. Lawson of the coast and geodetic survey, who proceeded to Los Angeles, and superintended the selection of a site, and erection of a building, in June and July, 1882.

In July, 1882, the instruments, were shipped to Los Angeles, Cal., in the care of Mr. Werner Suess, a skilful mechanician in the coast-survey, and who had attended to the mounting of the instrument in 1878, and to its packing up after the test trial was complete.

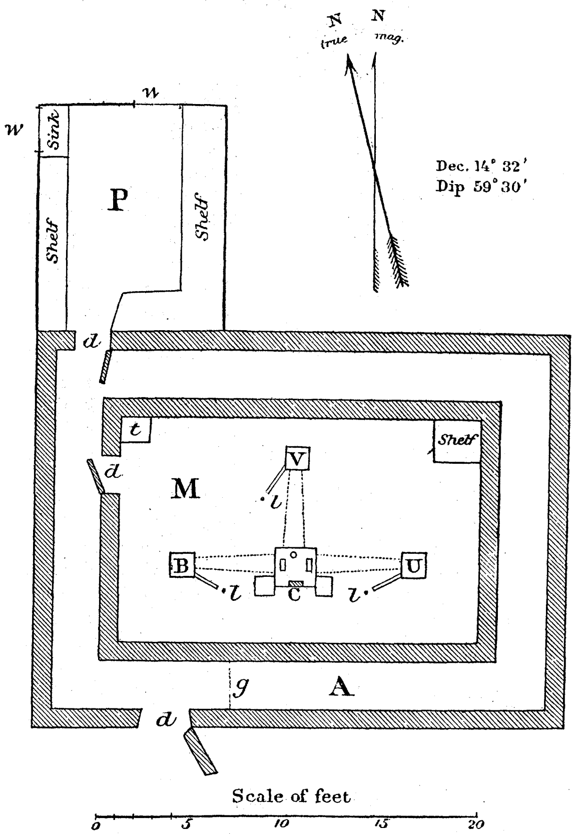
At the same time, the writer was assigned to the charge of the observatory, with instructions to mount and adjust the instrument, determine its constants, and proceed to bring out a continuous record of the changes in the elements of the earth's magnetism. Leaving Washington July 26, he arrived in Los Angeles Aug. 7, 1882, where he found Mr. Suess in waiting, and the observatory complete.

After arranging preliminaries, the work of mounting and adjusting the instrument was begun, and pushed forward as rapidly as possible. Observations for the determination of the constants and scale values were made; the compensation of the vertical-force magnet for temperature was made; temperature coefficients were determined; and finally, on Sept. 28, every thing was in readiness, and the first sensitive paper was put upon the cylinders, and the first record made. The first few days were in the nature of a trial. A slight re-adjustment was made on Oct. 13, after which every thing worked satisfactorily. On Oct. 31 the horizontal and vertical force constants were redetermined; and since that date the instrument has continued to work almost perfectly, and to make a complete and continuous record of the changes of all the magnetic elements.

The observatory is situated in latitude 34° 03′ N., longitude 118° 15′ W. from Greenwich, and 317 feet above the level of the sea. It is on a rather steep hillside sloping to the south-west in the grounds of the Branch normal school in the city of Los Angeles, exactly one mile, in a direct line, from the centre of the plaza, or park, in the centre of the old town, or about a mile from the central business part of the town. Street-cars run within two squares of the observatory. It is on adobe soil underlaid by clay, and in the midst of an orange plantation formerly known as Belle Vue Terrace.

The observatory is built of redwood fastened with copper nails, is double walled, with an air-space 2.5 feet between the walls; which walls are fourteen inches thick, and filled with adobe soil. It is twenty-eight feet long by twenty-one feet wide, and painted white. The entrance to the observatory is on the south side. On the north side is the photographic or dark room, P, where the various photographic processes are carried on. This room is twelve feet long by ten feet wide. The accompanying plan will show the arrangement of rooms and instruments. The three magnets are placed, the unifilar or declinometer, U, to the east, the bifilar or horizontal-force magnetometer, B, to the west, and the vertical-force magnetometer, V, to the north, of the central driving-clock, C. A picture of the instrument, showing it as a whole, and also showing details, may be found in Gordon's Electricity and magnetism. For illumination, student-lamps burning kerosene-oil

are used, and yield satisfactory results. The record is made on paper sensitized by the bromo-iodide process. The paper is sensitized at the observatory. Each trace contains two days' record; and the record is absolutely complete and continuous, except the time lost in changing papers to begin a new record, and in 'moving spots,' or shifting the luminous dots to get the second day's record on the same sheet. The time required for the first operation is from seven to eight minutes; for the second, from two to three minutes. Thus only about ten minutes are lost in two days, or an average of five minutes per day,—



a quantity too small to be of any importance on any occasion thus far observed.

One minute of time on the traces is represented by $\frac{1}{100}$ of an inch approximately, and a movement through one minute of arc by the unifilar magnet is represented on the trace by $\frac{3}{100}$ of an inch. A motion of the bifilar magnet of one scale division, represented on the trace by 0.027 inch, corresponds to a change of horizontal force of about its $\frac{1}{9000}$ part. The traces can readily be read off within half a scale division, or changes of force of its $\frac{1}{18000}$ part are recorded. This adjustment has not proved too sensitive, as the luminous dot has never left the recording cylinder, except once for a short time during the great magnetic storm of November, 1882.

Visitors are admitted to the observatory, and the traces generally show their presence by a break in the curve.

The instrument records, as is well known, changes of declination, changes of horizontal force, and changes of vertical force. Each of these changes is recorded on a separate sheet, or trace as it is called; and thus, on an average, forty-five traces are produced each month. These traces are six inches by sixteen inches and a half, and are made on plain photographic paper prepared for use at the observatory.

This preparation consists of two processes, salting and silvering. The salting process, as it is called, consists in soaking the paper from ten to fifteen minutes in a bath of iodide and bromide of potassium, with a little tincture of iodine added, after which the paper is hung up to dry. This process is carried on in the daylight.

The silvering or sensitizing process is carried on in a room as dark as can well be made, and then lighted up dimly with a red lantern. Some difficulty has been found in keeping the room dark enough, and on some occasions the silvering has been done at night.

For silvering, four wooden trays are placed in a row: the first containing a bath of nitrate of silver, acetic acid, and water; the second, distilled water; the third, a weak solution of chloride of ammonium; and the fourth, distilled water. A sheet of salted paper is then floated on tray no. 1, special care and some skill being required to prevent (*a*) any of the solution from getting on the *back* of the sheet, and (*b*) any air-bubbles from clinging to the front side of the sheet. The first defect produces stains, and the second, spots. In about nine minutes the paper is transferred to tray no. 2, being floated on as in the case of no. 1, and a new sheet is floated on tray no. 1. In about nine minutes more, the sheets are moved forward, as before; the paper in no. 2 is floated on no. 3; that in no. 1 is transferred, as before, to no. 2, and a new sheet floated on no. 1. This continues till tray 4 is reached; after which the sensitizing is complete, and the paper is then hung up to dry in the dark. Special care is necessary in hanging up the wet paper to avoid stains from the fingers, from the line, or from the pin which holds the paper on the line.

After drying thoroughly, the papers are taken down, packed in a large envelope, and kept in a dark drawer to be used as needed. From this envelope the sheets are transferred to the three recording cylinders prepared to carry them. They remain two days upon the cylinders, and thus receive two days' record. At quarter-past nine A.M. of each alternate day the papers are changed.

Over the central driving-clock is hung a heavy orange-flannel curtain. To change papers, the attendant, with the envelope of sensitive paper, goes

behind this flannel curtain, through which sufficient light from the three lamps comes to enable the change to be made without further artificial light. The orange flannel serves to satisfactorily exclude actinic light.

The traces, removed from the cylinders, are then carried in a large envelope to the dark room, and there developed, the developer used being pyrogallic acid. The best developments are those which take place rather quickly, in about ten to fifteen minutes. When the development is slower, the traces are usually found inferior. After the development is complete, the traces are fixed in hyposulphite of soda. cleansed in a saturated solution of alum, washed for about two hours in running water, and then hung up to dry. After drying, the date is stamped upon them. The exact instant of beginning and ending of each line on the trace, together with the corresponding scale value, is written on. Time observations, with sextant and artificial horizon, are taken from time to time, usually monthly, to regulate the standard chronometer.

After the traces have been thus completed, they are practically paper negatives, from which any number of copies may be made photographically. Two sets are made by the well-known blue-print process. The traces require no special treatment, such as oiling, waxing, etc., for the successful application of this process.

For tabulating from the traces, it is found most convenient to use a ruler subdivided into hourly divisions for the time scale, and a triangular piece of card-board upon the edge of which is ruled the scale corresponding to the trace to be read. The unifilar and bifilar traces have all been read, tabulated, and the means calculated. The vertical-force traces have not yet been read.

There is also in the magnet-room of the observatory a thermograph, which records the temperature every half-hour. From the records produced by it, the time of maximum temperature in the observatory is found to be about five P.M., and the time of minimum temperature, about half-past eight A.M. At these hours the thermometers under the bell glasses and near the magnets are read; and from these readings it appears that the magnets are subjected to an average daily range of temperature of about $1\frac{3}{4}$° C.

On the 14th, 15th, and 16th of each month, observations are made to determine the absolute declination, dip, and intensity. These observations are made in the usual manner of taking such observations by field parties in the coast and geodetic survey. Monthly reports and returns of results are made to the superintendent of the survey.

The declinations and dips have all been computed, but the intensities only approximately as yet. The following table contains the declinations and dips resulting from the monthly absolute determinations. Each declination is the mean derived from the elongation on three successive days, and each dip is the mean of six sets with two needles on the same three days.

U. S. magnetic observatory at Los Angeles, lat. 34°03′, long. 118°15′ W. G.

	Declination.	Dip.
1882, Sept. 14, 15, 16	14°35.5′ E.	59°30.1′
Oct. 14, 15, 16	33.7	30.2
Nov. 14, 15, 16	34.6	29.7
Dec. 14, 15, 16	32.7	31.6
1883, Jan. 14, 15, 16	35.1	30.8
Feb. 14, 15, 16	31.5	28.4
March 14, 15, 16	32.4	31.7
April 14, 15, 16	32.1	29.2
May 14, 15, 16	32 5	29.7

The horizontal intensity is approximately 5.97 in British units = 0.275 dyne.

U. S. magnetic observatory,
Los Angeles, Cal., June 1, 1883.

NOTES AND NEWS.

Professor Huxley has been elected president of the Royal society of London, in the place of Mr. Spottiswood.

— The recently issued report of the signal-office for 1881 contains a record of primary and secondary observing stations, established in that year in Alaska, with summaries of observations at some Alaskan stations in preceding years. There is also some account of the fitting-out of the Greely expedition to Lady Franklin Bay and that to Point Barrow. But the most important article for arctic students is the report of Prof. E. W. Nelson on the meteorology of St. Michaels, Norton Sound, where, as is well known, he had been stationed for four years; his leisure being employed in pursuing investigations into the natural history and ethnology of the region with the greatest energy, devotion, and success. The article itself being a summary and an abstract, with somewhat wider limits in regard to the treatment of auroras and the so-called 'polar band' formation of clouds, it will not be attempted to condense it here, but merely to call attention to some of its leading features. According to observations by Danenhower, the position (hitherto somewhat uncertain) of St. Michaels is latitude 63° $28\frac{1}{4}$′, and longitude 162° $04\frac{3}{4}$′ west. The mean annual temperature for the period is 25°.5 F. The highest observed temperature was 75°, and the lowest, — 55°. A curious fact was noted with great regularity. In early winter darkness comes on between three and four P.M., and the temperature falls until about six P.M., when a *rise* follows of two or three hours' duration, and sometimes five or six degrees in extent, followed by the usual steady nocturnal fall. It does not result from changes in the wind, but may be due to greater radiation immediately after sunset from the land, resulting in local atmospheric movements, causing warmer air from the adjacent sea to flow in the vicinity of the station.

Alongshore, winds N., N.E., S., S.E., S.W., are most prevalent. Winds off the sea, N.W. and W., are the least frequent, not exceeding together over ten per cent of the whole. Topographical bias is, however, distinctly evident, as at most stations in Alaska.

The measured precipitation averaged twelve inches and a quarter, to which Mr. Nelson estimates a correction of one-half more must be added for unmeasurable drizzle and blown snow. The record and discussion of the aurora is a valuable contribution to the subject, and cannot be summarized. Thunderstorms are almost unknown. Lightning was observed but twice, and no thunder was heard during the whole period. It is referred to as reported common on the upper Yukon in summer; but in 1865–68, by the explorers of the Telegraph expedition on the upper part of the river, thunder and lightning were not observed on a single occasion. There are but two seasons at St. Michaels, — winter (October–May) and summer (the remaining five months). The sea is open until about Oct. 15; and the ice disappears in the spring, usually in early June. The tides are small, but over the shallow sea adjacent the rise in level due to gales is often sufficient to submerge the marshy shores for miles inland. Gardening is not a success, except for turnips, radishes, and lettuce. The earliest birds, chiefly geese, begin to arrive in April; and the migration continues to June, the main body of birds arriving between May 15 and 25. Most of the birds leave for the south in August, and the first sharp frost of September sends away the laggards.

— On the 1st of January, 1883, there were in existence 79 societies of geography, distributed all over the world, with about 38,000 members.

— The American society of mechanical engineers met at Cleveland, O., June 14, President E. D. Leavitt, jun., of Cambridge, Mass., in the chair. Eighty members were present, and fifty-four were elected, raising the total membership to four hundred and sixteen. The papers were generally short, plain, and practical. Mr. J. K. Holloway described a steam starting gear for throwing marine engines 'off the centre.' It consists of a steam-cylinder and a friction-wheel on the main shaft, which can be actuated by the auxiliary steam-cylinder. The device works either way, and may be applied repeatedly if necessary. Mr. Charles N. Comly detailed his experience with lubricating materials, resulting in the substitution of grease for oil. Other members had found grease the cheaper lubricant, but had observed that it had a much higher coefficient of friction than oil. Mr. J. E. Sweet described a new method of casting iron pipe having flanges, making chilled flange-faces and cored bolt-holes. Other papers remain to be reported. During the session, it was announced that an honorary degree had been conferred on President Leavitt by the Stevens institute of technology.

— W. H. Edwards announces that he will not, at present, complete the Synopsis of species commenced in the tenth part of his Butterflies of North America, but substitute for it a mere list of species, which will be issued with the next (concluding) part of the second series.

RECENT BOOKS AND PAMPHLETS.

Annuaire de l'électricité pour 1883. (1re année), par A. Révérend. Paris, *Gauthier-Villars*, 1883. 216 p., illustr. 8°.

Blanchet. Notice sur la naturalisation à Bayonne d'une nouvelle plante exotique. Dax, *impr. Justère*, 1883. 15 p. 8°.

Delfau. De la maladie de la vigne causée par le phylloxéra et de son traitement efficace, facile et économique. Perpignan, *impr. de l'Indépendent*, 1883. 34 p. 8°.

English, T. Alfred, Haussen, C. Julius, and Sturgeon, J. Report on a scheme for supplying compressed air motive-power in the town of Birmingham; with tables and formulae for calculating the useful effect obtained from compressed air, and examples and diagrams showing the application thereof; with confirmatory report by Prof. H. Robinson. New York, *Spon*, 1883. 60 p., illustr. 4°.

Farmer, E. J. The resources of the Rocky Mountains; being a brief description of the mineral, grazing, agricultural, and timber resources of Colorado, Utah, Arizona, etc. Cleveland, 1883. illustr. 8°.

Forbes, P. R. Sciences and spiritualism. Paris, *impr. Schlaeber*, 1883. 16 p. 8°.

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